# SPECIAL PROVISIONS

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## 1. PROJECT DESCRIPTION

The project generally includes the removal and replacement of four concrete fish rearing raceways (two double banks), construction of a new concrete show pond and new site security lighting and electrical improvements. The project includes a Base Bid and one Additive Alternate, generally described as follows:

Base Bid: Remove and replace four concrete fish rearing raceways (two double banks), including piping connections and miscellaneous raceway metals. Site electrical improvements including four new utility poles with security lighting and electrical improvements to the existing feed shed and spawn house. New asphalt paving between the new raceways.

Additive Alternate #1: Construction of a new concrete show pond, including new inlet and discharge piping, and a paved walking path to the pond.

## 2. SITE INSPECTION AND PREBID CONFERENCE

All Bidders should satisfy themselves as to the construction conditions by personal examination of the site of the proposed work and any other examination and investigation that they may desire to make as to the nature of the construction and the difficulties to be encountered.

A prebid conference will be held on site. See Invitation To Bid in these Contract Documents for time and location. Those interested in bidding the project are encouraged to attend this meeting.

## 3. PROJECT RELATED CONTACTS

Wherever in these Documents the word "Owner" appears, it shall be understood to mean:

Owner: Montana Fish, Wildlife & Parks
Design and Construction Unit
1522 9th Avenue, PO Box 200701
Helena, MT 59620-0701
Contact: Troy Monroe
Telephone: (406) 841-4000

Wherever in these Documents the word "Engineer" appears, it shall be understood to mean Robert Peccia & Associates, Inc. The firm of Robert Peccia & Associates, Inc. has been duly authorized by the Owner as the Engineer for the engineering design, submittal review, and construction observation and will serve as the "Engineer" for those functions as related to this project.

Engineer: Robert Peccia & Associates
825 Custer Avenue, P.O. Box 5653
Helena, MT 59601
Contact Person: Craig Jenneskens, P.E.
Telephone: (406) 447-5000

## 4. ADDITIONAL INSUREDS

In accordance with the insurance requirements outlined in the General Conditions, the following entities shall be included as additional insureds:

OWNER:
Montana Department of Fish, Wildlife & Parks
ENGINEER:
Robert Peccia & Associates, Helena, MT

Use the Additional Insured Endorsement CG 20,32 or equivalent, acceptable to the Owner and Engineer.

## 5. SAFETY STANDARDS

The Contractor shall be solely and completely responsible for conditions of the jobsite, including safety of all persons (including employees) and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours. Safety provisions shall conform to U.S. Department of Labor (OSHA), and all other applicable federal, state, county, and local laws, ordinances, codes, and regulations. Where any of these are in conflict, the more stringent requirement shall be followed. The Contractor's failure to thoroughly familiarize himself with the aforementioned safety provisions shall not relieve him from compliance with the obligations and penalties set forth therein.

The Contractor shall develop and maintain for the duration of this contract a safety program that will effectively incorporate and implement all required safety provisions. The Contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.

The duty of the Engineer to conduct construction review of the work does not include review or approval of the adequacy of the Contractor's safety program, safety supervisor, or any safety measures taken in, on, or near the construction site.

The Contractor, as a part of his safety program, shall maintain at his office or other well-known place at the jobsites, safety equipment applicable to the work as prescribed by the aforementioned authorities, all articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of persons (including employees) who may be injured on the jobsite.

If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer. In addition, the Contractor must promptly report in writing to the Owner and the Engineer all accidents whatsoever arising out of, or in connection with, the performance of the work whether on, or adjacent to, the site, giving full details and statements of witnesses.

If a claim is made by anyone against the Contractor or any Subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Owner and the Engineer, giving full details of the claim.

The Contractor shall take all necessary provisions for safe handling of chemical amendments and potentially hazardous wastes, including apprising himself of hazards, developing safety plans, providing emergency and decontamination services, and developing spill containment procedures.

## 6. GENERAL CONSTRUCTION REQUIREMENTS

A. Quality Assurance. The Engineer will monitor the construction of work covered by this section to determine if the work is being performed in accordance with the contract requirements. The Engineer does not have the authority or the means to control the Contractor's methods of construction. It is, therefore, the Contractor's responsibility to utilize all methods, equipment, manpower, and other means necessary to assure that the work is installed in compliance with the Drawings and Specifications, and laws and regulations applicable to the work. All buried work items shall be installed in the presence of the Engineer or may not be considered for payment.

B. Grade and Alignment. The Engineer will provide benchmark elevations throughout the entire project area as necessary. The Contractor shall provide, with his own equipment, tools, material, and labor, all intermediate line and grade control necessary to install the work within the tolerances specified. The Contractor shall calibrate and maintain all line and grade control equipment, including transits, levels, lasers, and other equipment, periodically to assure their accuracy.

C. Tolerances. Construction tolerances for the work, shall be as outlined in the Technical Specifications.

D. Construction Limits. Where construction limits, or property lines, are not specifically called out on the Drawings, the limit shall be 20 feet, when measured from the centerline of the new pipe, or to the adjacent property line, whichever is less. Disturbance and equipment access beyond this limit is not allowed without the written approval of both the Engineer and the owner of the affected property. If so approved, disturbance beyond construction limits shall meet all requirements imposed by the landowner; this includes existing roads used and/or improved as well as the construction of new access roads. Special construction, reclamation, or post-construction road ripping or other closure provisions required by the landowner on access roads beyond the construction limits shall be performed by the Contractor at no additional cost to the Owner.

E. Areas of Disturbances. Approved areas of disturbance are those areas disturbed by construction activities within the construction limits and along designated or

approved access routes. Such areas shall require reclamation and revegetation operations, including grading to the original contours, topsoiling with salvaged or imported topsoil, seeding, fertilizing, and mulching as specified herein.

Other areas that are disturbed by the Contractor's activities outside of the limits noted above will be considered as site damage or unapproved areas of disturbance subject to the repair and replacement quality as specified herein. Such areas will also require the reclamation and revegetation operations noted above and as specified herein, but costs of such work shall be borne by the Contractor. This includes areas selected by the Contractor outside the defined construction limits for mobilization, offices, equipment, or material storage.

The Contractor shall order sufficient materials to perform the required work for all areas of disturbance. The Owner will pay for the required revegetation work in all approved areas of disturbance. The Contractor will pay for the required revegetation work in all unapproved areas of disturbance.

## 7. ENGINEERING INTERPRETATIONS

A. Engineering Decisions: It is realized that timely engineering decisions on construction activities or results have an important bearing on the Contractor's schedule. On this project the Engineer will make every effort to have a Resident Project Representative (RPR) readily available to the project during the construction period, who has the authority to make judgment calls on matters dealing with interpretation of the plans and specifications, with the one qualification; that he shall have the right to take twenty-four (24) hours to confer with other Engineers before giving said decision.

B. When the decision affects a plan design or specification change, it should be realized that more time may be required than twenty-four (24) hours to gain the necessary Owner and funding source participation in the decision process including time for formal change order preparation as required.

## 8. DISPUTES

A. Scope. This section covers the procedures to be followed in the event any part of the work or any change thereto becomes disputed and agreement between the Contractor and the Owner cannot be reached. Arbitration of unresolved disputes is discussed in the General Conditions.

B. Notification. The Contractor shall give written notice to the Engineer indicating that he is not in agreement with certain aspects of the work. The Engineer may give the Contractor a written directive to proceed with the disputed work and to maintain complete and accurate records of the time and costs associated therewith.

C. Maintenance of Progress. Time is of the essence in completion of this project. The Contractor shall continue to actively execute all work that is not directly affected by the disputed work. When the Engineer gives the Contractor a written notice to proceed with the disputed work, the Contractor shall, without delay, issue a notice of protest and intent to claim and proceed with the disputed work. Failure of the Contractor to actively and effectively pursue the work shall be sufficient grounds for the Owner to terminate the services of the Contractor as provided in Section 15.02 of the General Conditions except, however, that a 10-day notice of termination shall be given only once. Resumption of work by the contractor, after receiving notice of termination, will not reinstate the 10-day notice period; and the Owner may at any time after the 10-day period immediately take whatever action the Owner deems necessary to maintain the construction schedule, at the Contractor's expense.

## 9. ENGINEERING, INSPECTIONS, AND TESTING

Scope. All work will be tested and inspected to insure compliance with the Contract Documents. Complete payment will not be made until the Contractor has demonstrated that the work is complete and will perform as required. See Section 01400 – Contractor Quality Control and Owner Quality Assurance for the specific sitework material testing and quality control requirements.

## 10. CONSTRUCTION SURVEYS BY CONTRACTOR

A. Northings, eastings and elevations are available from the Engineer in an ASCII format for the established control points and subsequent design features. The Contractor shall provide all construction staking, slope staking and blue tops as required in the course of the work.

B. Layout Surveys. The construction plans show key proposed elevations and any design survey control points obtained by the Engineer which are considered suitable for construction layout. Additional control points and bench marks needed to layout the project shall be established by the Contractor for control of the work and reference by the Contracting Officer/Engineer. Additional control points and benchmarks established by the contractor may not be based on the key proposed elevations. The Contractor shall lay out the work by establishing all lines and grades at the site necessary to construct the work and shall be responsible for all measurements that may be required for the execution of the work to the location and limit marks prescribed in the Specifications or on the Contract Drawings.

C. The Contractor shall provide an independent survey crew to provide survey control. Construction staking may be performed by the Contractors personnel, but subsequent surveys to determine final elevations shall be performed by the original independent survey crew. Checks for conformance with grades required

by contract plans and specifications will be performed at appropriate intervals to insure that grading is to the planned elevations.

D. All notes shall be reduced and in a form acceptable to the Contracting Officer/Engineer (i.e. N,E,Z,D ASCII format or similar approved format.)

E. If control points and/or bench marks are disturbed during the course of construction, replacement of all horizontal and vertical control shall be made by the Contractor at no additional cost to the Owner.

F. The Contractor shall be responsible for verification of all existing pavement elevations where new pavement will abut existing pavement. The Contractor shall notify the Engineer of any discrepancies between plan elevations and verified field elevations or dimensions.

G. The Owner may require that work be suspended at any time when control points established at the site by the Contractor are not reasonably adequate to permit checking of the work.

## 11. UTILITIES

The exact locations of existing underground utilities that may conflict with the work are not precisely known. It shall be the Contractor's responsibility to contact the owners of the respective utilities and arrange for field location services.

A. Notification. The Contractor shall contact, in writing, all public and private utility companies that may have utilities that may be encountered during excavation. The notification shall include the following information:

* The nature of the work that the Contractor will be performing.
* The time, date and location that the Contractor will be performing work that may conflict with the utility.
* The nature of work that the utility will be required to perform such as moving a power pole, supporting a pole or underground cable, etc.
* Requests for field location and identification of utilities.

A copy of the letter of notification shall be provided to the Engineer. During the course of construction, the Contractor shall keep the utility companies notified of any change in schedule or nature of work that differs from the original notification.

B. Identification. All utilities that may conflict with the work shall be the Contractor's responsibility to locate before any excavation is performed. Field markings provided by the utilities shall be preserved by the Contractor until actual excavation commences. All utility locations on the Drawings should be considered approximate and should be verified in the field by the Contractor. The

Contractor shall also be responsible for locating all utilities that are not located on the Drawings.

C. Removal or Relocation of Utilities. This section applies to electric power, gas, telephone and television utilities. Whenever there is a direct conflict between the work being performed and the utility, the Contractor shall be responsible to coordinate with the utility company and to remove, relocate or temporarily support the utility during the course of construction. Any charges by the utility for removing, relocation or temporarily supporting the utility shall be paid for by the Contractor.

D. Public Utilities. Water, sewer, storm drainage, street lighting and other utilities owned and operated by the public entities shall, unless otherwise specifically requested by the utility owner, be removed, relocated, supported or adjusted as required by the Contractor at the Contractor's expense. All such work shall be in accordance with these Specifications, or the Owner's Standard Specifications or written instructions when the work involved is not covered by these Specifications.

E. Other Utilities. Utilities owned and operated by private individuals, railroads, school districts, associations, or other entities not covered in these Special Provisions shall, unless otherwise specifically requested by the utility owner, be removed, relocated, supported or adjusted as required by the Contractor at the Contractor's expense. All work shall be in accordance with the utility owner's directions, or by methods recognized as being the standard of the industry when directions are not given by the owner of the utility.

F. Damage to Utilities and Private Property. The Contractor shall protect all utilities and private property and shall be solely responsible for any damage resulting from his construction activities. The Contractor shall hold the Owner and Engineer harmless from all actions resulting from his failure to properly protect utilities and private property. All damage to utilities shall be repaired at the Contractor's expense to the full satisfaction of the owner of the damaged utility or property. The Contractor shall provide the Owner with a letter from the owner of the damaged utility or property stating that it has been repaired to the utility owner's full satisfaction.

G. Water Mains and Services. All water mains and services exposed during construction shall be adequately supported and protected from freezing at all times. Sections of water mains shall not be valved off without first giving the Owner sufficient notification and receiving authorization from the Engineer. Unless otherwise permitted in writing by the Owner, water mains and services shall not be shut off for more than 3 hours. All affected water service customers shall be notified by the Contractor in advance of any interruption of service.

Whenever a water main or service is damaged as a result of the Contractor's operations, the Contractor shall take immediate steps to repair the damage and disinfect all water mains and services contaminated as a result of the damage.

Existing water services from the mains to private property which interferes with trenching operations may be cut and replaced at the Contractor's option and expense provided the requirements for notification, length of interruption, and disinfection specified above are adhered to.

H. Maintenance of Flows. Adequate provisions shall be made for maintaining the flow of sewers, drains, and water courses encountered during construction. Culverts, ditches, fences, crosswalks, and structures which are disturbed by this construction shall be satisfactorily restored to their original condition upon completion of the work.

I. Structures. The Contractor shall exercise every precaution to prevent damage to existing buildings or structures in the vicinity of his work. In the event of such damages, he shall repair them to the satisfaction of the owner of the damaged structure at no cost to the Owner.

J. Overhead Utilities. The Contractor shall use extreme caution to avoid a conflict, contact, or damage to overhead utilities, such as power lines, street lights, telephone lines, television lines, poles, or other appurtenances during the course of construction of this project.

K. Buried Gas and Petroleum Lines. The Contractor shall provide some means of overhead support for buried gas and petroleum lines exposed during trenching to prevent rupture in case of trench caving.

L. Pavement Removal. Where trench excavation or structure excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spade-bitted air hammer, concrete saw, colter wheel, or similar approved equipment to obtain a straight, square clean break. Pavement cuts shall be 2 feet wider than the actual trench opening as indicated in the Drawings.

M. Survey Markers and Monuments. The Contractor shall use every care and precaution to protect and not disturb any survey marker or monuments, such as those that might be located at lot or block corners, property pins, intersection of street monuments or addition line demarcation. Such protection shall include markings with flagged high lath and close supervision. No monuments shall be disturbed without prior approval of the Engineer. Any survey marker or monument that is disturbed by the Contractor during the construction of the project shall be replaced at no cost to the Owner by a licensed professional land surveyor.

## 12. SITE ACCESS

The Contractor shall not unreasonably encumber the site or public rights-of-way with his materials and construction equipment. The Contractor shall comply with all reasonable instructions of the Owner's representative and the ordinances and codes of government agencies regarding signs, traffic, fires, explosives, danger signals and barricades.

## 13. CONSTRUCTION FACILITIES AND CONTROLS

A. Temporary Utilities. The Contractor shall provide all temporary electrical, lighting, telephone, heating, cooling, ventilating, water, sanitary, first aid, fire protection, and other utilities and services necessary for the performance of the work. All fees, charges, and other costs associated therewith shall be paid for by the Contractor.

B. Barriers.

* The Contractor shall temporarily remove all signs, fences, barricades, minor structures, and other obstructions that interfere with the prosecution of the work. Removal shall not extend beyond designated construction limits or rights-of-way without first obtaining written authorization from the owner of the barrier.

* Fences and barricades used for the confinement or exclusion of livestock, animals, or persons shall be replaced at the end of each work day to the extent necessary to perform the restrictive intent of the barrier.

* Unless otherwise directed by the Engineer or indicated on the Drawings, all barriers so removed shall be replaced following the completion of the work to as good or better condition than existed prior to the start of work. This requirement applies to small trees and decorative shrubs as well as signs, fences, barricades, and minor structures.

* The Contractor shall replace at his own expense all barriers damaged or destroyed.

C. Security. The Contractor shall provide all security measures necessary to assure the protection of his plant and equipment, products and materials in storage, completed work, and the project in general.

D. Temporary Controls. The Contractor is reminded state, federal, and local laws and regulations require the Contractor to provide controls to limit or prevent nuisance and pollutive work methods and procedures.

## 14. DISPOSAL OF USED WATER

Disposal of used water shall be the responsibility of the Contractor. Discharges to the surface are subject to permit and regulatory requirements. Discharge of chlorinated water is the responsibility of the Contractor. Discharge to sewer or storm drains must be coordinated with the Owner.

## 15. SITE DEWATERING

Site dewatering, if required, shall consist of that dewatering necessary to construct the work as specified, including all excavation and embankment. The Contractor shall submit a plan for dewatering to the Engineer. The Contractor shall also be responsible for obtaining the necessary permits for discharge of the dewatering operations.

## 16. SMOKE AND DUST CONTROL

The Contractor shall have informed himself of all applicable State Board of Health requirements and similar state or federal requirements pertaining to control of or abatement of air pollution. He shall have provided or be prepared to provide such air pollution control measures as are required to comply with the minimum standards established by such agencies.

Hauling of material and transport of equipment along public roadways or through the towns and adjacent other structures and dwellings shall require effective dust abatement procedures. This also applies to the unloading and placement of spoils material at deposition sites. The Contractor shall utilize environmentally sound methods for watering and/or otherwise chemically treating dust generating surfaces to comply with all applicable legal standards for airborne particulates. Prior to any work, the Contractor shall submit a written plan for dust abatement procedures identifying at a minimum the following:

* Times and nature of dust generating activity on public roads and at deposition sites.
* Nature and chemical characterization of dust abatement materials to be used.
* Method of application of dust abatement materials to be used.
* Time schedule for application of dust abatement materials to be used.
* Availability of equipment and operators for emergency application of dust abatement materials at other than scheduled times.

Watering for dust control is considered incidental to the Contract and shall be performed at no additional cost to the Owner.

## 17. WATER POLLUTION / SEDIMENT CONTROL

The Contractor shall comply with all laws and regulations of the Montana Department of Environmental Quality and with all other federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent

pollution of streams, lakes, ponds, and reservoirs with fuels, oils, bitumens, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

Sediment control provisions shall be used whenever work is conducted adjacent to drainages or watercourses to control silt in runoff. Adequate silt barriers or sediment traps shall be used to comply with statutory requirements for all stream-side work, both during and after working hours. Measures used may include staked straw bales, sediment ponds, and/or staked silt fence (Mirafi "Enviro-Fence", or equal). Sediment control measures shall be considered incidental to the Work, and no separate payment for them will be allowed. The Contractor will be solely responsible for the selection and implementation of sediment control measures to assure permit and statutory compliance.

## 18. SANITARY FACILITIES

The Contractor shall furnish, install, and maintain ample sanitary facilities for all workers. As the needs arise, a sufficient number of enclosed temporary toilets shall be conveniently placed as required by the sanitary codes of state and local governments. All such facilities and services shall be furnished in strict accordance with existing and governing health regulations. Costs for furnishing, installing, and maintaining sanitary facilities shall be considered incidental to other items of work, and no additional compensation will be allowed.

## 19. USE OF COMPLETED PORTIONS

The Owner shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding that the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of any work not completed in accordance with the Contract Documents. If such prior use increases the cost of or delays the completion of incomplete work or causes refinishing of completed work, the Contractor shall be entitled to such extra compensation or extension of time or both, as agreed by the Owner.

## 20. RECORD DRAWINGS

A. The Contractor’s Superintendent shall maintain at the project site, a “Record Set of Drawings” showing field changes, as-built elevations, unusual conditions encountered during construction, and such other data as required to provide the Owner with an accurate “as constructed” set of record drawings. The Contractor shall furnish the “Record Set” to the Engineer following the Final Inspection of the Project.

B. <u>The Contractor’s final estimate and final payment will not be processed until the “Record Set” of drawings are received and approved by the Engineer.</u>

## 21. CONSTRUCTION PERMITTING

Contractor is responsible for all permits necessary for completion of the proposed project. Permits may include, but not be limited to, the following:

- All permits required for dewatering of the construction site
- All permits required for storm water discharge and disposal, erosion control, stream impacts, etc.
- Electrical permitting

## 22. RACEWAY LEAKAGE TESTING

Once raceway construction is complete, all raceways shall be leak tested. Each raceway shall be filled to normal operating level for a period of 3 days. Leakage testing will be accomplished with visual observation of the interior raceway walls. In order to perform the visual inspection, adjacent raceways on either side of the raceway being tested shall be left empty and dry. All cracks, leaks and irregularities shall be properly repaired by the Contractor at no additional cost to the Owner. All repairs shall be completed to the satisfaction of the Engineer and Owner.

## 23. SOILS INFORMATION

No soils or geotechnical information were obtained for this project. It is the responsibility of the Contractor, at his discretion, to conduct all investigations and determine the soil type and digging conditions that may be encountered with this Project.

## 24. ESTIMATED QUANTITIES

A. Estimated Quantities. All estimated quantities stipulated in the Proposal and other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the work; and (b) for the purpose of comparing proposals submitted for the work. It is understood and agreed that the actual amounts of work done and materials furnished under unit price items may vary substantially from such estimated quantities. The actual quantities will depend on the conditions encountered at the time the work is performed, and the unit prices apply.

## 25. UNIT PRICE WORK

The unit price of an item of Unit Price Work shall be subject to reevaluation and adjustment under the following conditions:

A. if the total cost of a particular item of Unit Price Work amounts to 25% or more of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by Contractor differs by more than 10% from the estimated quantity of such item indicated in the Agreement; and

B. if there is no corresponding adjustment with respect to any other item of Work; and

C. if Contractor believes that Contractor has incurred additional expense as a result thereof; or if Owner believes that the quantity variation entitles Owner to an adjustment in the unit price, either Owner or Contractor may make a claim for an adjustment in the Contract Price in accordance with the General Conditions if the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

## 26. PROJECT MEETINGS

A. Preconstruction Conference. After the Contract has been awarded, but before the start of construction, a preconstruction conference will be held at a time and place mutually agreed to by the parties. The conference shall be attended by the following: the Contractor and his superintendent; the principal subcontractors; representatives of principal suppliers and manufacturers, as appropriate; the Engineer; Representatives of the Owner; and others as appropriate.

Unless previously submitted, the Contractor shall bring the following submittals to the conference: list of proposed Subcontractors; proposed construction schedule; schedule for submitting shop drawings and other submittals; scheduled procurement dates; construction technique submittal forms (as applicable); preliminary payment schedule; and tentative schedule of values. Work shall not start prior to the Engineer's receipt of these submittals.

B. Progress Meetings. Progress meetings shall be held monthly to review progress and requests for payment, maintain coordination, update and modify scheduling requirements, and resolve any problems that might develop. The Engineer shall preside at the meeting.

## 27. GOVERNING STANDARDS AND REGULATORY REQUIREMENTS

A. Jurisdiction. The performance of this work shall be under the jurisdiction of the following agencies, departments, and standards and compliance with the requirements thereof is required:

Federal Level: United States law; United States Corps of Engineers; Environmental
Protection Agency.

State Level: Montana Code Annotated; Montana Department of Environmental Quality; Dept. of Fish, Wildlife & Parks (SPA); Department of State Lands; the Department of Natural Resources and Conservation; the Montana Building Codes

Division; Uniform Building Code, (latest edition); Uniform Plumbing Code, (latest edition); Uniform Mechanical Code, (latest edition); Uniform Fire Code (latest edition); National Electric Code, (latest edition).

Permits. The Contractor must also comply with the requirements of any permits obtained for the project by the Owner. These permits may include stream bed crossing permits, flood plain permits, etc. Copies of any of these permits are available upon request from the Engineer. However, the Contractor shall be responsible for obtaining any permits regarding the discharge of any water related to the construction of this project (this includes a Montana Department of Environmental Quality 3A Permit).

Local Level: City ordinances and regulations.

B. Contractor's Responsibility. The Contractor shall familiarize himself with the requirements of all regulatory agencies pertaining to the performance of the work on the project. The Contractor shall perform all work in accordance with the regulatory requirements. Any conflict between the Contract Documents and the regulatory requirements shall be brought to the immediate attention of the Engineer.

## 28. WEED AND AQUATIC INVASIVE SPECIES CONTROL

Prior to mobilizing equipment on the project site, the Contractor shall clean his equipment and vehicles to assure no weeds are imported. If there is an abnormal growth of noxious weeds on a project site after construction as determined by the Owner or local weed control authority, the Contractor will be responsible for weed control for the duration of the contract warranty.

**The Contractor shall ensure that all equipment is clean, free of dirt and mud, and dry prior to mobilizing on-site to avoid the spread of AIS (aquatic invasive species). Any equipment which has been used in or around other waters must be disinfected prior to entering the site.**

## 29. REGULAR HOURS AND WEATHER DAYS

A. Regular Hours. The regular work week shall consist of five working days, Monday through Friday, with regular working hours of 8:00 a.m. to 5:00 p.m. Written requests to perform any work outside of the regular work week or normal working hours must be delivered to the Owner and Engineer no less than 48 hours prior to the planned start of the work.

B. Weather Days. In the event inclement weather or the aftermath of inclement weather prevents the Contractor from performing any compensable work for a minimum of 60% of the Regular day or other work period approved by the Owner, he may request a credit for that day. No credit for inclement weather will

be allowed on non-working days. A request for a weather day must be submitted to the Engineer by the end of each calendar day being requested.

C. Winter Shutdown. In the event of the onset of winter weather, a winter shutdown will be granted upon written request and mutual agreement of the Contractor and Owner. Work will commence in the spring at the earliest possible date.

D. Standby Time. No separate payment will be made for standby time, inactive periods beyond Contractor control or inactive periods resulting from requirements of this Contract. Such time will be considered incidental to the required work. Standby time can be expected, but is not limited to waiting for completion of other related contractors work.

## 30. CONTRACTOR REIMBURSED ENGINEERING COSTS

The Contractor shall reimburse the Owner the full cost of Engineering services in the event the Engineer incurs unscheduled employment necessitated by the Contractor.

Examples of unscheduled employment of the Engineer are the following Contractor actions:

1) Working more than forty (40) hours per week, more than five (5) days per week and Saturdays, Sundays, and holidays.

2) Furnishing materials or equipment not in conformance with Contract Documents necessitating redesign by the Engineer.

3) Working beyond the time of completion established in the Notice to Proceed with Construction.

4) Retests by the Engineer of tests that have failed.

5) Retests by others for tests that require Engineer's presence.

6) Repeated review of submittals and shop drawings that have not been approved.

7) Additional inspection as a result of unacceptable work.

8) Other services that are within the Contractor's control to avoid.

The Engineering fees to be reimbursed by the Contractor shall be according to the following schedule:

1) Labor: At the Engineer's current billable rates, including overhead, as referred to in the Agreement between the Owner and Engineer, plus 15% profit.

2) Other Consultant: At actual cost plus 10%

3) Mileage: 4X4 @ $0.56/mi.; 2WD @ $0.51/mi.

4) Per Diem: IRS allowable rate

5) Other expenses and laboratory testing: Actual Cost + 10%

6) Field Testing: Engineer's current billable rate for specific equipment utilized

Contractor shall make payment of these Engineering services by deduction from the project progress payments or final payment or by invoice to the Contractor.

The Engineering contract will be analyzed at the end of the project to determine whether any unscheduled employment of the Engineer, during the schedule contract time, resulted in a cost savings to the Owner. If, as a result of working more than 40 hours per week, five days per week, the Contractor completes the project within the scheduled time, and if the overtime results in a reduced contract time and cost savings to the Owner, no damages will be assessed for the unscheduled employment of the Engineer during the scheduled contract time. Damages will be assessed as stipulated for each day the work remains uncompleted beyond the scheduled contract time.

## 31. TRAFFIC CONTROL

The Contractor shall schedule his construction operations in a manner which will assure that: 1) the safety and convenience of motorists and pedestrians, and the safety of construction workers, are adequately met at all times; and 2) the project is completed in a manner most beneficial to the project as a whole.

## 32. GENERAL EQUIPMENT STIPULATIONS

A. General. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

B. Coordination. Contractor shall coordinate all details of the equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

C. Manufacturer's Experience. Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past five years.

D. Workmanship and Materials.

1. Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.
2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable Engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
3. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4-inch thick.

E. Value Engineering. Manufacturer may submit for review and approval proposed modifications to the design, materials or arrangements specified. Request shall clearly state the advantages, cost savings or other reasons for the proposed change. Acceptance of any proposed changes will be the sole discretion of the Engineer as proscribed under the "or equal" and "substitute item" clauses of the General Conditions.

F. Seismic Loading Design Provisions. Machinery, equipment, and components such as tanks, piping, and electrical panels, including their supports and anchorages, designed by manufacturers or suppliers, shall be designed in accordance with the provisions of the latest edition of the Uniform Building Code to withstand seismic loads for the Seismic Zone appropriate for the project location in addition to other loads. Design shall be performed by a licensed Professional Engineer familiar with seismic design. Submittals shall be certified, by the Design Engineer, that equipment designs conform to all applicable Uniform Building Code requirements including provisions to withstand seismic loads.

G. Single Source. Like items of equipment shall be the end product of one manufacturer in order to achieve standardization.

H. Manufacturer's Representative.

1. Where specified, manufacturer shall provide a Manufacturer's Representative as required to assist in the installation, adjustment, startup, certification and operational training.
2. Manufacturer's Representative shall be an employee of manufacturer who is factory trained and knowledgeable in the technical aspects of the products and systems.

3. When the services of the representative are specifically required for a listed time period, the days shall represent eight (8) hours straight time exclusive of Saturdays, Sundays and holidays. Travel time is considered incidental to the work and will not apply to the required listed time.
4. If listed time is not required, or is modified, an appropriate adjustment in payment shall be made.
5. If the provided Manufacturer's Representative is found deficient in training or experience by the Owner or Engineer, the manufacturer shall furnish another acceptable representative.

I. Certification of Compliance.

1. Where specified, furnish certification of compliance for products specified to a recognized standard or code prior to the use of such products in the work.
   a. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by a certification of compliance.
   b. Certifications shall be signed by the manufacturer of the product; state that the components involved comply in all respects with the requirements of the Specifications.
   c. Furnish certification of compliance with each lot delivered to the job site and clearly identify the lot so certified.
2. Products used on the basis of a certification of compliance may be sampled and tested at any time. The fact that a product is used on the basis of a certification of compliance shall not relieve Contractor of responsibility for incorporating products in the work which conforms to requirements of the Contract Documents. Products not conforming to such requirements will be subject to rejection whether in place or not.
3. Engineer reserves the right to refuse permission for use of products on the basis of a certification of compliance.

J. Manufacturer's Certification of Proper Installation. Where manufacturer's certification is required in the Specifications, the manufacturer shall provide certification stating the following:

1. The product or system has been installed in accordance with the manufacturer's recommendations.
2. The product or system has been inspected by a manufacturer's authorized representative.
3. The product or system has been serviced with the proper lubricants.
4. Applicable safety equipment has been properly installed.
5. Proper electrical and mechanical connections have been made.
6. Proper adjustments have been made and the product or system is ready for functional testing, plant startup, and operation.

K. Functional Test Certification. Where a certification of functional testing is specified for certain equipment, Contractor (as applicable to the equipment furnished) shall state in writing that:

1. Necessary hydraulic structures, pumps, valves, etc. have been successfully tested.
2. Necessary equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate they are operational.
3. Adjustments and calibrations have been made.
4. The systems and subsystems are capable of performing their intended functions.
5. The facilities are ready for performance testing, or for startup and intended operation, as applicable.

L. Performance Test Reports. Prepare and submit performance test reports where specified for equipment systems.

M. Accessories. All equipment shall be provided with the following accessories as applicable.

1. Safety Guards: All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard in complete accordance with the requirements of OSHA. Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
2. Anchor Bolts: Equipment manufacturers shall provide anchor bolt size, location and loads, including seismic loading. Anchor bolts will be provided by others, unless noted to be supplied by the equipment manufacturer in the Equipment Specifications.
3. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

4 Identification Plates: A 16-gauge stainless steel piece of equipment identification plate shall be securely mounted on each in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification number indicated in this Specification and/or shown on the Drawings.

5. Special Tools: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
6. Spare Parts:

a. Furnish all spare parts specified or purchased prior to requesting the issuance of a Certificate of Completion and/or operation of the equipment by the Owner.

b. Spare parts and special tools shall be properly packaged to avoid damage, in their original cartons insofar as possible, and shall be stored in a location as determined by the Engineer. Any spare parts found to be damaged or otherwise inoperable at the time of delivery shall be replaced or, if approved by the Engineer, satisfactorily repaired.

c. Spare parts and special tools shall be labeled with a minimum 3-inch by 6-inch manila spare parts tag with such information as the part description, the manufacturer's part number, the applicable equipment description and manufacturer, the quantity of parts delivered in each package, the applicable specification section, and the Contractor's and Project's name. This tag shall be firmly affixed to, and prominently displayed on the outside of each package.

N. Lubrication.

1. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.
2. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.
3. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

## 33. BLASTING

If explosives are necessary for excavation purposes, the Contractor must comply with all local, state and federal regulations governing the use of explosives and shall be responsible for obtaining any necessary blasting permits. The Contractor's use, transportation, handling, and storage of explosives for construction blasting shall be under the supervision and direction of a construction blaster licensed by the Montana Division of Workers' Compensation. A copy of the blasting license and the blaster's experience shall be submitted to the Engineer before any explosives are brought to the project area. It will be the blaster's responsibility to design and

initiate blasting. The Contractor is responsible for ensuring compliance with all laws and regulations concerning explosives.

The Contractor shall submit a copy of the blasting plan to the Engineer. This plan is for record and construction purposes and shall not relieve the Contractor from using proper blasting procedures. The plan shall include, at a minimum, the following items:

- Methods and equipment for transporting explosives and detonators.
- Type and location of storage facilities.
- Type and quantity of explosives.
- Primer assembly procedure and location.
- Employee training programs.
- Provisions for protecting persons, structures, private, and public property.
- Provisions for developing and distributing a daily blasting schedule.
- Provisions for disposal of explosives, blasting agents, and associated materials.
- Hours of proposed blasting.

Additionally, the Contractor shall be bound by and adhere to Section 203, Excavation and Embankment, pages 82-85 in the 1995 Edition of the Montana Department of Transportation "Standard Specifications for Road and Bridge Construction" dealing with blasting.

Following blasting, the Contractor shall, at no additional cost to the Owner, regrade any surface damage or subsidence and repair any other damage that may have occurred due to the blasting including damage claimed by outside parties. The Contractor shall be required to obtain insurance required for the use of explosives and shall not commence work until such insurance has been submitted and approved by the Owner and the Engineer. The Contractor shall also submit written confirmation that all landowners and any other potentially-affected parties have been notified of the proposed blasting.

No additional payment will be allowed for blasting or repair of any resultant damage. The Contractor assumes complete and absolute liability for any damage or injury caused by blasting, including any repairs needed or compensation awarded. The Contractor also agrees to hold harmless the Owner, the Engineer, and the landowner from any claims resulting from his blasting operations.

## 34. SYSTEM COMMISSIONING AND CLEANUP

A. Scope. This section covers the final preparations required to place the various components into operation.

B. Final Conditioning. Before final acceptance is made, the entire work shall be cleaned and conditioned. This shall consist of the following:

1. Grease, oil, grit, dirt, grime, debris, and other foreign materials shall be removed;
2. Nicks, scratches, voids, holidays, and other imperfections in painted surfaces shall be touch-up painted with matching paint;
3. Chips, voids, cracks, and other imperfections in exposed concrete shall be repaired with methods and materials approved by the Engineer;
4. Threaded fasteners shall be checked for tightness;
5. Doors, windows, hatches, and other mating surfaces shall be adjusted to fit square in their respective framework;
6. Driveways and parking areas shall be fine-graded; and
7. Landscaping shall be fine-graded and re-established where necessary.

C. System Demonstrations.

1. The Contractor and his major manufacturers shall demonstrate the operation of each and every piece of equipment to the Engineer, Owner, and the Owner's operator. The Contractor shall demonstrate all maintenance requirements and reference the requirements of the Operations and Maintenance Manual for each piece of equipment.
2. A plan for system start-up shall be submitted to the Engineer for approval, before the start-up will be allowed.

D. Removal of Construction Equipment, Tools, and Supplies. At the completion of this Contract, before acceptance of the work by the Owner, the Contractor shall remove all of his equipment, tools, and supplies from the property of the Owner. Should the Contractor fail to remove such equipment, tools, and supplies, the Owner shall have the right to remove them at the Contractor's expense.

## 35. MEASUREMENT & PAYMENT

1. Scope. This section describes the method of measurements and basis of payment for all work covered by the Contract Documents. For the purposes of this Contract, this Measurement and Payment Section shall govern and take precedence over all other references to measurement and payment (with exception to any addenda) referenced in these specifications. References to the *Montana Public Works Standard Specifications (MPWSS)* in these Contract Documents are for technical specifications only for items so referenced; the Measurement and Payment provisions of the *MPWSS* do not apply.

2. Bid Prices.

   A. The bid price for each item of the Contract in the Bid Proposal shall cover all work shown on the Drawings and required by the specifications and other Contract Documents. All costs in connection with the work, including furnishing all materials, equipment, supplies and appurtenances; providing all required construction support plants, equipment, and tools; constructing and maintaining dewatering systems; and performing all necessary labor and supervision to fully complete the work, shall be included in the unit and/or lump sum prices bid in the Bid Proposal. The amounts shown on the Bid Proposal shall be the contract price.

   B. No item that is required by the Contract Documents for the proper and successful completion of the work will be paid for outside of or in addition to the prices submitted in the Bid Proposal. All work not specifically set forth as a pay item in the Bid Proposal shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the prices bid.

3. Retainage. Retainage in the amount of 5% will be withheld from each progress payment.

4. Estimated Quantities. Any estimated quantities stipulated in the Bid Proposal or other Contract Documents are approximate and are to be used; (1) only as a basis for estimating the probable cost of the work and (2) for the purpose of comparing the bids submitted for the work.

5. Incidentals. The following measurement and payment sections do not necessarily name all the incidental items required by the Contract Documents to complete the work. The cost of all such incidentals shall be included in the various related bid items. Final payment will not be made until the work is complete and accepted by the Owner.

6. Method of Measurement.

   A. No measurement of items contained in this Contract will be made on items representing a lump sum bid.

   B. Measurement of items contained in this Contract will be made on the number of items represented by each unit installed and described in further detail in the payment section.

7. Basis of Payment.

   A. Mobilization, Bonding & Submittals (May Not Exceed 5% of Total Base Bid):

* General: This bid item shall include mobilization, bonding, insurance and submittals.
* Work Included:
  - All labor, tools, equipment, materials, and incidentals necessary to complete the work as shown and specified;
  - Transport and set up all equipment, materials and other items needed to complete the project;
  - Bonding and Insurance; and
  - Provide all submittals, the construction schedule, and other paperwork required prior to construction start up.
* Measurement: Measurement for mobilization, bonding & submittals shall be one lump sum (LS) item.
* Payment: Payment shall be by the lump sum (LS) item listed on the Proposal. Payment of this bid item will be allowed once the Contractor is fully mobilized, all submittals are received, and bond and insurance certificates have been submitted and approved; thereon 100% payment will be allowed. This bid item may not exceed five percent (5%) of the total base bid.

B. Raceway Removal and Replacement:

* General: This bid item shall include removal and replacement of four concrete raceways, complete.
* Work Included:
  - All labor, tools, equipment, materials, and incidentals necessary to complete the work as shown and specified;
  - Transport and set up all equipment, materials and other items needed to complete demolition;
  - All demolition of concrete raceways and piping as indicated on the Demolition Plan in the Construction Drawings and in the project Special Provisions and Technical Specifications;
  - Dust control during demolition;
  - All necessary environmental and human protective measures;
  - Proper handling, loading, hauling, unloading and statutorily compliant disposal of concrete, soil, piping, metals and other materials as indicated on the Demolition Plan in the Construction Drawings and in the project Special Provisions and Technical Specifications;
  - Tipping fees and disposal fees charged by the disposal facility.
  - All work necessary to complete the entire project which is not specifically included in any other bid item;
  - Permitting, permit adherence and compliance.
  - All construction surveys, staking and required material testing (compaction, concrete tests, etc.);
  - Relocation of site utilities as may be required for construction.
  - Site dewatering, if necessary;
  - All earthwork required to construct the raceways, including excavation, structural fill, embankment, backfill, compaction and testing;

- Construction of reinforced concrete floor slab, raceway walls and flow control structures, including formwork, reinforcement, metal embeds, concrete placement and finishing;
- Provide and install gratings, jump screens, screen guides and damboard guides;
- Reinstall raceway inlet piping, valves and fittings; and
- Raceway leak testing.

* Measurement: Measurement shall be one lump sum (LS) item.
* Payment: Payment shall be by the lump sum (LS) bid item listed on the Proposal.

C. Site Electrical Improvements:

* General: This bid item shall include all work associated with electrical improvements and modifications, complete.
* Work Included:

- All labor, tools, equipment, materials, and incidentals necessary to complete the work as shown and specified;
- Transport and set up all equipment, materials and other items needed to complete construction activities;
- New breakers and connections to existing panel inside Spawn House;
- Installation of new utility poles, buried conductor, security lights, switches, motion sensors, timers and convenience outlets;
- Replacement of two wall-mounted security lights on exterior of Spawn House;
- New lighting, switches, load center, disconnect and outlets at the existing Feed Shed;
- Inspection of existing wiring and electrical inside Spawn House, including written summary report and cost estimates; and
- Ensuring all electrical work conforms to the 2014 National Electrical Code.

* Measurement: Measurement shall be one lump sum (LS) item.
* Payment: Payment shall be by the lump sum (LS) bid item listed on the Proposal.

D. Asphalt Pavement:

* General: This bid item shall include construction of all new asphalt pavement in the vicinity of the new raceways, complete.
* Work Included:
  - All labor, tools, equipment, materials, and incidentals necessary to complete the work as shown and specified;
  - Transport and set up all equipment, materials and other items needed to complete demolition;
  - Clearing, grubbing, debris disposal, topsoil salvaging and stockpiling, and all other work necessary to prepare the material source site for excavation;
  - Provide project specific mix design;
  - Excavation, crushing, screening and all other work necessary to meet

material specifications;

- Provide all bituminous material (PG 58-28) required to complete the work in accordance to the mix-design and specifications;
- Loading, hauling or other transportation to place the material;
- Provide material testing and refinery certifications of the bituminous product;
- Provide all materials required to complete the work in accordance to the mix-design and specifications.
- Loading, haul or other transportation required to place the material;
- Place, grade and compact the base course material and asphalt pavement meeting minimum density specifications at the locations, depths, lines, grades and elevations required to construct the project;
- Provide material testing, including production aggregate production control testing and mix-design of the product; and
- Final grading, site clean-up, topsoil replacement, seeding, fertilizing, mulching and all other reclamations required at the material source at the material source at the conclusion of the work. Reclamation procedures and final results must meet the approval of the material site landowner and Engineer.

* Measurement: Measurement shall be one lump sum (LS) item.
* Payment: Payment shall be by the lump sum (LS) bid item listed on the Proposal.

E. New Show Pond:

* General: This bid item shall include construction of the new concrete show pond, complete.
* Work Included:
  - All labor, tools, equipment, materials, and incidentals necessary to complete the work as shown and specified;
  - Transport and set up all equipment, materials and other items needed to complete demolition;
  - Permitting, permit adherence and compliance.
  - All construction surveys, staking and required material testing (compaction, concrete tests, etc.);
  - Relocation of site utilities as may be required for construction.
  - Site dewatering, if necessary;
  - All earthwork required to construct the show pond, including excavation, structural fill, embankment, backfill, compaction and testing;
  - Construction of reinforced concrete floor slab, raceway walls and flow control structures, including formwork, reinforcement, metal embeds, concrete placement and finishing;
  - Provide and install screen guides and damboard guides;
  - Install new show pond supply and inlet piping, valves and fittings;
  - Install new show pond discharge piping and fittings;

- Construct new paved path to show pond (see “Asphalt Pavement” pay item description above); and
- Show pond leak testing.

* Measurement: Measurement shall be one lump sum (LS) item.
* Payment: Payment shall be by the lump sum (LS) bid item listed on the Proposal.

**END OF SPECIAL PROVISIONS**

# TECHNICAL SPECIFICATIONS

# TECHNICAL SPECIFICATIONS

## CONTENTS

**Incorporation of Montana Public Works Technical Specifications:**

The Technical Specifications contained in Divisions 2 and 3 (with the exception of Sections 03210 and 03310) in the Montana Public Works Standard Specifications (MPWSS), Sixth Edition, April 2010, and all subsequent Addendum, are hereby incorporated by reference and made a part of this Contract.

In the event of a discrepancy between the MPWSS Technical Specifications and the following Technical Specifications contained within this bound document, the following bound versions shall take precedence.

**NOTE: Measurement and Payment (M&P) provisions included in the MPWSS Technical Specifications do not apply and are superseded by the Special Provisions of this Contract.**

**Technical Specifications Bound Within this Document:**


**Division 1 – General Requirements**
- 01400 Contractor Quality Control and Owner Quality Assurance

**Division 2 – Sitework**
- 02220 Structural Excavation, Backfill and Embankment

**Division 3 – Concrete**
- 03051 Cold Weather Concreting Procedures
- 03052 Hot Weather Concreting Procedures
- 03210 Reinforcing Steel
- 03251 Expansion and Construction Joints
- 03300 Cast in Place Concrete
- 03360 Grout

**Division 5 – Metals**
- 05500 Fabricated Metal Work and Castings

**Division 16 – Electrical**
- 16005 Electrical

## SECTION 01400

## CONTRACTOR QUALITY CONTROL AND OWNER QUALITY ASSURANCE

### PART 1: GENERAL

1.1 DESCRIPTION

A. This section describes the Contractor quality control testing requirements and Owner's quality assurance program.

B. All work will be tested and inspected to insure compliance with the Contract Documents. Complete payment will not be made until the Contractor has demonstrated that the work is complete and will perform as intended.

1.2 REFERENCES

A. The following ASTM publication is a part of this specification.

ASTM E 329 Evaluation of Testing and Inspection Agencies as Used in Construction

### PART 2: MATERIALS --- NOT USED

### PART 3: EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for quality control tests and inspections to control production and construction processes. Include in the Contractor quality control system an internal organization, plans, and procedures to produce the specified end product. Assure the system covers all construction operations, both on-site and off-site, and is keyed to the construction sequence. Quality control testing frequency is at the Contractor's discretion, except where test frequencies are specifically required elsewhere in these Specifications for individual products. If quality control testing is specifically required by these Specifications, the results of those tests shall be shared simultaneously with the Contractor, Owner and Engineer. Some testing requires the hiring of an independent testing firm as specified.

B. Sampling and testing to assure specification conformance are performed by the Owner or the Owner's testing agency as quality assurance testing.

C. The Owner may select a testing agency to perform quality assurance testing. If so, the Owner will pay for (or provide) the quality assurance testing. Quality

assurance testing frequency is at the Owner's discretion for individual products. The Owner may not elect to provide quality assurance testing if a reputable independent testing firm is providing the quality control testing for the Contractor, and the results are shared simultaneously with the Contractor, Owner and Engineer.

D. Quality control tests required of the contractor include, but are not limited to, the following tests. Costs associated with these tests shall be paid by the Contractor. All tests requiring the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent professional testing laboratory, acceptable to the Engineer, and paid for by the Contractor.

1. Initial aggregate quality tests including: stripping tests, volume swell tests, fracture tests, wear tests, sand equivalency and soundness tests on proposed aggregate sources if not taken from a previously-accepted source (with evidence that the aggregate meets these specifications and can be provided to the Engineer).

2. Moisture-density curves of the different types of subgrade, subbase, base courses, and trench backfill material encountered or supplied.

3. Nuclear Densometer compaction testing, performed by a qualified independent testing agency, of the subgrade, subbase, base course, asphalt pavement, and trench backfill materials to establish and maintain the compactive effort required to meet the compaction specifications.

Quality control testing is performed following the standards and frequency in the technical specifications for individual products, or as follows:

The following minimum compaction testing procedures shall apply to all utility and roadway construction projects. A professional engineer, or his designated representative, at Contractor's expense, shall be retained to provide the following tests and frequency. Random longitudinal test locations are required. The following are minimum compaction test requirements. For project areas containing less than 300 linear feet of improvements, a minimum of one compaction test for each improvement shall be required for the improvements listed below.

<u>Utility Trenches and Underground Structures:</u>

Density test shall be taken upon the first lift of the trench backfill material above the pipe and at every two (2') feet vertically through the trench and at the surface. A test series consists of the multiple tests, beginning at eighteen (18") inches above the pipe, every two feet vertically through the trench and at the surface as required.

Horizontal Frequency:

Utility Main – At least one field density test series for every 200 lineal feet of utility main and at every road crossing.

Service Lines – At least one field density test series for every service line per utility type.

Open Pit – At least one field density test series for every manhole, water valve, storm inlet, curb inlet, vault, etc.)

Each test location shall be separated horizontally from a prior test location.

Road subgrade:

Gradation test and proctor submitted to Engineer for each existing material type encountered.

At least one field density test series for every 500 square yards of roadway/parking area. A test series consists of three compaction tests at various locations and depths throughout the subgrade.

Subbase Course:

One gradation test for every 200 cubic yards of material placed. Proctor submitted to Engineer for each material type.

At least one field density test series for every 200 cubic yards placed. A test series consists of three compaction tests at various locations and depths throughout the subbase.

Base Course:

One gradation test for every 200 cubic yards of material placed. Proctor submitted to Engineer, for each material type.

At least one field density test series for every 200 cubic yards placed. A test series consists of three compaction tests at various locations and depths throughout the base.

Asphalt and/or Portland Cement Concrete:

Contractor shall obtain and submit mix design(s) to Engineer for approval.

Gradation test shall be required for all projects planned to exceed 500 tons of asphalt. Gradation test shall be conducted for each 1,000 tons or days production, whichever is less.

At least one field density test series for every 1,000 tons of asphalt or days production, whichever is less. A test series consists of three cores in various, random locations upon the asphalt to determine thickness and density.

1. Portland Cement Concrete job-mix formula for any concrete work on the project including, but not limited to thrust blocks, sidewalks, slabs and foundations.

2. The Contractor shall arrange for and pay for an independent laboratory to take and break concrete test cylinders, slump, and air testing as called out in the plans or technical specifications. A minimum of 4 concrete cylinders shall be made and tested for each 20 CY of concrete placed. One cylinder shall be tested at 7-days, two at 28-days, and one retained in reserve for later testing if required.

3. The Contractor shall arrange for and pay for an independent laboratory to prepare a bituminous surfacing job-mix formula and to test for compaction and job-mix compliance during the paving operations.

4. The Contractor shall arrange for and pay for all tests required not specifically identified above as being performed by the Owner.

5. Retesting as provided above.

E. Testing Results: Results obtained from the Contractor's certified testing lab shall be provided within 2 working days, plus the time normally required to perform the test, and shall be delivered in writing simultaneously to the Contractor, Owner and Engineer. Any delay, in the receipt of these tests shall cause the work to be stopped until results are obtained and analyzed by the Contractor, Owner and Engineer. No concrete or asphalt may be installed until all test results for underlying material have been received and are in accordance with specifications.

F. Performance of Tests and Inspections: The Contractor, Owner, Engineer, and representatives of funding and regulatory agencies may perform periodic inspections and tests to determine compliance with the Contract Documents. The Contractor shall provide qualified manufacturer's representation during tests of equipment and special procedures as required by the Contract Documents.

G. Acceptance and Rejection of Materials: Acceptance and rejection will generally be determined from tests made of the various subbase, and base courses complete and in-place in the field. While the Owner and Engineer may, during the course of construction, make tests at the source or point of production; it is the

responsibility of the Contractor to conduct, control and test his production operations in such a manner that the material produced will meet the Specification requirements.

H. Use of Nuclear Densometer for Acceptance Testing: In lieu of the sand cone method of field density determination, acceptance testing of the subgrade, subbase, base course, and trench backfill materials will be accomplished using a nuclear gage in accordance with ASTM-D-2922.

I. Inspection:

1. The Contractor shall inspect the work as it is being performed. Any deviation from the requirements shall be immediately corrected. Prior to any scheduled inspection by the Owner or Engineer, the Contractor shall again inspect the work and certify to the Owner and Engineer that he has inspected the work and it meets the requirements of the Contract Documents.
2. The Engineer's representative will observe work and compare the quality of the work with the requirements of the Contract Documents. Any discrepancies noted shall be brought to the Contractor's attention, who shall immediately correct the discrepancy. Failure of the Engineer to detect a discrepancy will not relieve the Contractor of his ultimate responsibility to perform the work as required.
3. Should the Engineer incur additional costs to make additional observations as a result of unacceptable work, the Contractor shall reimburse the Owner for additional Engineering fees at the Engineer’s billable rates at the time of subsequent inspections.
4. Observation by the Engineer's representative shall not be considered as authorization to proceed with the work. Work progress and the performance of quality work are the Contractor's responsibility. The Engineer's observation is for the purpose of determining what work will be paid for and what work will not be paid for. If the Engineer detects a discrepancy between the work and the requirements of the Contract Documents at any time, up to and including final inspection, such work will not be completely paid for until the Contractor has corrected the deficiency.
5. The work will be subject to review by the Owner, and regulatory agencies, whose findings shall be as valid as those of the Engineer. The results of all such observations shall be directed to the Contractor through the Engineer.

J. Independent Services provided by the Contractor: The Contractor shall provide the following services at no additional cost to the Owner:

1. Field location of existing utilities involved in the work.
2. Preparation and certification of all required shop drawings and submittals.
3. Maintenance of project drawings which shall be accurately marked up with changes and conveyed to the Engineer at the completion of construction.

## 3.2 CONTRACTOR COOPERATION WITH QUALITY ASSURANCE AGENCY

A. Assure the Owner's personnel and quality assurance agency personnel have access to all work areas at all times work is in progress. Provide any special facilities or equipment to access work areas at Contractor's expense.

B. Notify the Engineer of the work ready for quality assurance testing. Establish and update the construction schedule to provide the Engineer estimated sampling/testing dates and times.

## 3.3 PAYMENT FOR TESTING

A. The Contractor shall pay for all quality control testing required in these specifications, including the cost of hiring an independent testing laboratory as necessary.

B. The Owner will pay for any/all quality assurance testing costs, if required.

**END OF SECTION 01400**

# SECTION 02220

# STRUCTURAL EXCAVATION, BACKFILL AND EMBANKMENT

## PART 1: GENERAL

### 1.1 DESCRIPTION

A. This section includes, but is not necessarily limited to, all excavation, embankment, backfill, borrow, granular leveling course, and all rough and finish grading for:

1. Backfill under all structures
2. Backfill within two feet of all structure walls
3. Embankments
4. Incidental excavation for utilities located under structures

### 1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.
1. Granular Leveling Course Gradation.
2. Structural Backfill Gradation.
3. Structural Backfill Proctor
4. Structural Fill and Embankment Proctor (more than one may be required).

### 1.3 GENERAL REQUIREMENTS

A. Excavation work shall be performed in a safe and proper manner with appropriate precautions taken against all hazards. Excavation shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

B. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

C. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill or embankment materials shall be installed on frozen surface s, nor shall frozen materials, snow or ice be placed in any backfill, fill or embankment.

D. All excavation, backfills, fills and embankment shall be protected from damage from rain and equipment operations. All structures, fences, and other objects not designated for removal shall be protected from damage at all times.

E. Compaction, when referred to as a percentage, shall mean the percentage of maximum laboratory density as determined by ASTM D698.

F. The excavation shall be constructed in accordance with OSHA standards.

G. Structural Backfill (6" minimum) shall be placed below all precast manholes, fiberglass sumps, slabs, footings, buildings, and all other structures.

H. Subgrade below and around structures shall be compacted as follows:

| | |
|---|---|
| Below Slabs and Footings: | 98% of minimum dry density |
| Foundation/Wall Backfill: | 95% of minimum dry density |
| Overlot Fill (traffic areas): | 95% of minimum dry density |
| Overlot Fill (non-traffic areas): | 90% of minimum dry density |

I. No rocks or lumps 2 inches or larger shall be allowed within 12 inches of any structure.

## PART 2: MATERIALS

### 2.1 FILL MATERIALS

A. All structural fill material shall be free of frost, organic material, rocks or lumps larger than 6 inches, and other deleterious materials. All material shall have uniform consistency in the entire fill and shall have a maximum plasticity index of 8.

### 2.2 GRANULAR LEVELING COURSE

A. Granular leveling course material under interior floor slabs shall consist of clean mineral aggregate with 100 percent passing the 1-inch sieve, not more than 5 percent passing the Number 4 sieve, and not more than 1 percent passing the Number 200 sieve.

### 2.3 STRUCTURAL BACKFILL AND EMBANKMENT

A. Structural backfill and embankment material shall be crushed gravel aggregate as specified in MPWSS Division 2.

## PART 3: EXECUTION

### 3.1 GENERAL

A. No work performed or installed shall be covered or enclosed by backfill or embankment until all required inspections, tests, and approvals have been completed. Any such work so enclosed or covered before it has been approved shall be uncovered at no additional cost to the Owner.

### 3.2 STAKING

A. All staking necessary to complete the excavation and embankment shall be provided by the Contractor.

### 3.3 EXCAVATION

A. Excavation shall be made as shown on the Drawings and shall be sufficient to provide an adequate and safe working area.

B. All excavation necessary to install utilities or structural appurtenances shall be made as required, maintaining the degree of compaction specified for the fill throughout all trenches.

### 3.4 PREPARATION OF SUBGRADE

A. Excavated subgrades under fills and embankments shall be graded and watered as necessary to achieve optimum moisture content, and compacted to a density of no less than 95 percent.

B. All deleterious material in the subgrade shall be removed to the extent determined by the Engineer and replaced with suitable embankment material and compacted as specified above.

C. Subgrades shall be protected from excessive moisture until the fill material is in place. Any subgrade saturated by rain or flooding shall be sub-excavated, backfilled, and recompacted as described by this specification at the Contractor's expense.

### 3.5 UNIFORMITY OF BACKFILL AND EMBANKMENT

A. All backfill and embankment material shall be selectively placed to provide a uniform consistency of material throughout the fill.

B. A uniform moisture content shall be maintained at or near optimum throughout the fill

to achieve maximum and uniform compaction.

C. All soft, spongy areas shall be excavated and the unstable material shall be replaced with suitable material and compacted as required.

3.6 TESTING AND INSPECTION

A. All backfill and embankments shall be tested by the Contractor and will be subject to inspection and testing by the Engineer. No further work shall proceed until all tests and inspections have been satisfactorily completed. Access to the work shall be given when requested.
   1. The Contractor is required to perform the compaction testing.
   2. The Engineer will spot check compaction only to determine the level of effort required to meet the compaction requirements. These tests will not constitute proof that the contractor is meeting the compaction level required.

B. The following spot checks and inspections will be performed:
   1. Compaction of structural backfill, select backfill, fill and embankments;
   2. Materials quality; and
   3. Grade and surface smoothness.

**END OF SECTION 02220**

# SECTION 03051

# COLD WEATHER CONCRETING PROCEDURES

## PART 1 GENERAL

### 1.1 DEFINITIONS

A. Cold weather is defined as a period when for more than 3 successive days the mean daily temperature falls below $40^{o}$ F or any day when the temperature is expected to fall or falls below freezing.

### 1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.

1. Not less than 30 days prior to expected placement of concrete under cold weather conditions, a complete procedure shall be submitted for review covering all aspects of protection of concrete and its ingredients from the detrimental effects of cold weather. Concrete placement during cold weather shall not commence prior to return of the approved procedure.

### 1.3 PRODUCT DELIVERY, HANDLING AND STORAGE

A. The concrete temperature, during placement in cold weather, shall not be less than $50^{o}$ F. Temperature measurements of the concrete as delivered to the job site shall confirm this requirement.

## PART 2: MATERIALS

### 2.1 WATER AND AGGREGATE

A. Water and aggregate may be preheated for cold weather placement; however, their temperature shall not exceed $150^{o}$ F. All methods and equipment for heating of water and aggregate shall be subject to the approval of the Engineer and shall conform to ACI 306.

## PART 3: EXECUTION

3.1 GENERAL

A. No concrete shall be placed on frozen ground.

B. The ground, against which concrete is to be poured, must be protected against freezing after its preparation, or the concrete placement shall be delayed until the ground has fully thawed out.

C. When temperatures are expected to be below $32^{o}$ F the night before the concrete is placed, all reinforcing steel, forms and the ground shall be preheated, for a minimum of 12 hours, under a minimum temperature of $50^{o}$ F.

D. When temperatures are expected to be below $32^{o}$ F any time before the concrete has reached strength of 1000 psi, the concrete must be adequately protected against frost damage by heating blankets, straw or insulation materials for a minimum of 7 days or until at least 1000 psi concrete strength has been reached. The concrete temperature shall at no time fall below $40^{o}$ F based on recording temperature monitors placed at a maximum of 50 feet on centers, each way, and around the circumference of the floor, wall, roof slab and wall-footing. Contractor shall provide heat as required to keep the concrete temperature as specified throughout the entire curing period of 7 days.

E. Weather prediction made by the nearest NOAA station, and corrected for the local elevation and environmental conditions, may be used to determine whether cold weather protection shall be required. Thermometers will be used by the Engineer and these readings shall determine whether cold weather protection shall be required and whether cold weather protection is adequate.

F. When combustion type heaters are used to maintain concrete temperatures within an enclosure, the exhaust gases shall be vented from the heater to the outside atmosphere so that the concrete is not exposed to the products of combustion.

G. There will not be any additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

**END OF SECTION 03051**

## SECTION 03052

## HOT WEATHER CONCRETING PROCEDURES

## PART 1: GENERAL

1.1 DEFINITIONS

A. Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal concrete properties. During hot weather, any or all of the methods specified herein for temperature control of concrete shall be used as required to maintain the concrete temperature below the limits specified.

1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.

1. Not less than 30 days prior to expected placement of concrete under hot weather conditions, a complete procedure shall be submitted for review covering the aspects of protection of concrete and its ingredients from the detrimental effects of hot weather. Concrete placement during hot weather shall not commence prior to the return of the approved procedure.

1.3 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Aggregate piles, cement bins and batch plant bins shall be shaded from direct rays of sunlight.

B. Aggregate piles shall be cooled by wetting and evaporation. Aggregate wetting shall be performed in such a manner that it will not cause wide variations in moisture content impairing slump uniformity.

1.4 GENERAL PRACTICES AND MEASURES

A. The following list of practices and measures, as described in ACI 305, may be used to reduce or avoid the potential problems of hot weather concreting:

1. Use concrete materials and proportions with satisfactory records in field use under hot weather conditions.

2. Use cool concrete.

3. Use a concrete consistency that permits rapid placement and effective consolidation.
4. Transport, place, consolidate, and finish the concrete with least delay.

5. Plan the job to avoid adverse exposure of the concrete to the environment; schedule placing operations during times of the day or night when weather conditions are favorable.

6. Protect the concrete against moisture loss at all times during placing and during its curing period.

B. There will not be any additional reimbursement made to the Contractor for costs incurred for placing concrete in hot weather.

## PART 2: MATERIALS

### 2.1 BATCHING AND MIXING

A. Concrete mix water shall be refrigerated or ice shall be added to the mix up to 100 percent of the water requirement. Ice, when introduced into the mixer, shall be in such form that it will be completely melted and dispersed throughout the mix at the completion of the mixing time. The mixing time shall be held to the minimum practicable consistent with producing concrete meeting the specified requirements.

B. All methods and equipment for cooling of water and aggregate shall be subject to the approval of the Engineer and shall conform to ACI 305.

## PART 3: EXECUTION

### 3.1 CONCRETE TEMPERATURE

A. The temperature of concrete, as delivered at the time and location of placement, shall not exceed $100^{o}$ F under any conditions. The temperature of concrete as delivered at the time and location of placement under the following combined ambient conditions, except concrete that will be deposited within wall or column forms, shall not exceed the following temperatures:

| Relative humidity less than % | Ambient temperature greater than °F | Maximum concrete temperature °F |
|---|---|---|
| 80 | 90 | 100 |
| 70 | 90 | 95 |
| 60 | 90 | 90 |
| 50 | 90 | 85 |
| 40 | 90 | 80 |
| 30 | 80 | 75 |
| 20 | 75 | 70 |

3.2 DELIVERY

A. Concrete shall be placed in the Construction within 90 minutes after the completion of mixing.

3.3 PREPARATION FOR PLACING

A. Elevated forms and reinforcing steel for beams and similar members shall be cooled by fog spraying and evaporation immediately prior to placing concrete. Forms shall be free of standing water when concrete is placed herein.

3.4 PLACING

A. Concrete shall be placed in shallower layers than under normal weather conditions if necessary to assure coverage of the previous layer while it will respond readily to vibration.

3.5 FINISHING

A. Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic-shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic-shrinkage cracking.

3.6 PROTECTION AND CURING

A. Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying and shall be kept continuously wet by fog spraying or other approved means.

**END OF SECTION 03052**

# SECTION 03210

# REINFORCING STEEL

## PART 1: GENERAL

### 1.1 DESCRIPTION

A. This section covers the work necessary to furnish, install and complete the reinforcing steel.

### 1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.

B. Shop drawings of detailed placing and bending lists for the Engineer's approval before the reinforcement is fabricated.

### 1.3 TEST CERTIFICATES

A. Mill test certificates shall be submitted to the Engineer to certify that the reinforcing steel meets the specified requirements. Mill test certificates shall be furnished and paid for by the Contractor.

B. In addition, the Engineer may require that test samples be taken and test certificates be furnished by a reputable material testing laboratory at the Owner's expense.

## PART 2: MATERIALS

### 2.1 DEFORMED REINFORCING BARS

A. Unless otherwise specified, reinforcing steel shall be Grade 60 billet steel conforming to ASTM A-615. ASTM A-615 Grade 40 steel shall be allowed for #3 and smaller bars.

B. Varying grades shall not be used interchangeably in structures.

C. All such reinforcing shall be deformed steel bars with deformations conforming to the requirements set forth in ASTM Specification A-615.

D. Steel bending processes shall conform to the requirements of ACI-318.

E. Bending or straightening shall be accomplished so that the steel will not be damaged.

F. Kinked bars shall not be used.

2.2 SUPPORTS

A. Bar supports shall conform to ACI 315.

B. Bar supports shall consist of approved high-density "adobes," stainless steel chairs, plastic spacers or plastic shim plates.

1. High-density adobes shall, as a minimum, be no less in compressive strength or cement content than the concrete in which it will be cast. Adobes manufactured from plastic or with low cement contents will not be accepted. Brick, broken concrete masonry units, spalls, rocks or similar materials shall not be used for support of reinforcing steel.

2. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view.

C. The vertical wall elements shall have mat spacers comprising of #3 bars of either “U-bar” or “Hairpin” type configuration placed in a maximum of a 4’-0” grid on center each direction.

2.3 WELDED WIRE FABRIC REINFORCEMENT

A. If specified on the Drawings, welded wire fabric shall be manufactured in accordance with ASTM A185. It shall be of new stock and free from rust when placed in the work.

2.4 STEEL TIE WIRE

A. Annealed steel tie wire shall be used to fasten the reinforcing steel in place.

## PART 3: EXECUTION

### 3.1 REINFORCING BARS

A. General:

1. Mild steel reinforcing bars shall be furnished, cut, bent and placed as indicated on the Drawings.

2. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease or other coating which might destroy or reduce its bond with concrete.

3. Steel reinforcement which is to be placed in the work shall be stored under cover to prevent rusting, and shall be placed on blocking such that no steel touches any ground surface.

4. All reinforcing steel placed in the work shall be tied together and supported in such a manner that displacement during placing of concrete will not occur.

5. When there is a delay in depositing concrete, reinforcement shall be re-inspected and cleaned when necessary.

B. Cutting and Bending:

1. Steel reinforcement shall be cut and bent in accordance with ACI 350, the CRSI "Manual of Standard Practice for Reinforced Concrete Construction" and with approved practices and machine methods, either at the shop or in the field.

2. Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and on the bending schedule.

3. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.

4. All bars shall be bent cold.

5. Reinforcing partially embedded in concrete shall not be field bent unless indicated on the Drawings.

C. Minimum Bar Spacing: The clear distance between parallel bars shall not be less

than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than one inch, nor less than the maximum size of coarse aggregate specified.

D. Concrete Cover (Minimum):

1. On all formed surfaces which will be exposed to water, ground or the elements, there shall be a nominal cover over the steel of 2 inches, with an installation tolerance of + 1/4 inch.

2. Unless otherwise specified in these specifications or shown on the Drawings, all reinforcing steel facing subgrades in footing and floors shall be given a nominal protective cover of 3.0 inch minimum.

3. No "bury" or "carrier" bars will be allowed unless specifically approved by the Engineer.

E. Splicing:

1. Except as shown or specified on the Drawings, reinforcing steel shall not be spliced at any location without specific approval by the Engineer. Splices in adjacent bars shall be staggered a minimum of one lap length.

2. Where permitted or required splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise on the Drawings, the bars at a lap splice shall be in contact with each other. In no event shall the lap be less than 38 diameters of the spliced bars, unless noted otherwise on the Drawings.

3. Unless specified or shown otherwise on the Drawings, bars shall be lap spliced in accordance with ACI 350 and shall be fastened together with steel tie wire. Lap splices shall be class “B” tension lap splices.

4. Unless shown otherwise on the Drawings, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in a subsequent concrete placement.

F. Supports:

1. All reinforcement shall be retained in place, true to indicated lines and grades, by the use of approved bar supports. The Contractor shall submit for Engineer's approval, samples of all bar supports he proposes to use along with a written description of where each bar support will be used.

2. The supports shall be of sufficient quantity, strength and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction.

3. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete.

4. The Contractor shall be held responsible for providing the appropriate quantity and type of bar supports.

G. Bar Tying:

1. Bars shall be tied sufficiently often to prevent shifting. There shall be at least three ties in each bar length (this shall not apply to dowel laps or to bars shorter than 4 feet, unless necessary for rigidity).

2. Slab bars shall be tied at every intersection around the periphery of the slab. Wall bars and slab bar intersections shall be tied at not less than every second intersection, but at not greater than the following maximum spacings:

| | Slab Bars (inches) | Wall Bars (inches) |
|---|---|---|
| Bars No. 5 and smaller | 30 | 24 |
| Bars No. 6 through No. 9 | 48 | 30 |
| Bars No. 10 through No. 11 | 60 | 48 |

H. Reinforcement Around Openings: Where reinforcing steel has to be cut to permit passage of pipe or to create openings, and should no detail be shown for extra reinforcing in such areas, the area of steel removed by the creation of the opening must be replaced by placing at least double the area of steel removed by the opening equally around the openings. The steel shall be placed such that it extends 5 feet beyond the opening on each side to provide for sufficient bond.

## 3.2 WELDED WIRE FABRIC REINFORCEMENT

A. General:

1. All necessary tie wiring, spacing chairs, or supports shall be installed to keep the welded wire fabric in place while concrete is being placed.

2. The welded wire fabric shall be bent as shown or required on the Drawings to fit the work. Welded wire fabric shall be rolled or otherwise straightened to make a perfectly flat sheet before placing in the Work.

3. Unless otherwise shown on drawings, all welded wire reinforcement shall be placed in the center of the respective concrete member.

B. Splicing:

1. Welded wire fabric shall be lap spliced as indicated on the Drawings. If the lap splice length is not indicated on the Drawings, the welded wire fabric shall be spliced in accordance with ACI 318 and no less than a minimum of 40 wire diameters of the lapped wire.

**END OF SECTION 03210**

## SECTION 03251

## EXPANSION AND CONSTRUCTION JOINTS

## PART 1: GENERAL

1.1 DESCRIPTION

A. This section covers the work necessary to furnish, install and complete expansion and construction joints.

1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.

B. Certified mill certificates showing that the material meets all of the requirements specified here-in. The Engineer, at his option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Owner. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.

1.3 OBSTRUCTIONS

A. Contractor shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor, wall and roof sections can be expected under temperature or other conditions.

## PART 2: MATERIALS

2.1 WATERSTOPS

A. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinylchloride compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Drawings.

B. No reclaimed PVC shall be used in the compound.

C. The finished waterstop material shall meet the following minimum requirements:

| | | | |
|---|---|---|---|
| 1. | Tensile strength | 2,000 psi | (ASTM D-412) |
| 2. | Ultimate elongation | 350% | (ASTM D-412) |

| | | | |
|---|---|---|---|
| 3. | Shore hardness | 75 ± 5 | (ASTM D-2240) |
| 4. | Specific gravity | 1.3 | (ASTM D-792) |
| 5. | Stiffness in flexure | 600 psi | (ASTM D-747) |
| 6. | Cold brittleness | -35° F | (ASTM D-746) |
| 7. | Water absorption: | 48 hours 0.320% max | (ASTM D-570) |
| 8. | Tear resistance | 290 lb./in. | (ASTM D-624) |

D. Manufacturer's Reference

1. For construction joints requiring a ribbed flat 4-inch PVC waterstop, use Greenstreak Style 781, or approved equal.
2. For construction joints requiring a ribbed flat 6-inch PVC waterstop, use Greenstreak Style 679, or approved equal.
3. For construction joints requiring a center-bulb 6-inch PVC waterstop, use Greenstreak Style 732, or approved equal."

2.2 Vinylex Corporations, 2636 Byington-Solway Road, Knoxville, TN 37921 (Phone 615-690-2211) and GREENSTREAK PLASTIC PRODUCTS, Box 7139, St. Louis, MO 63177 (phone 314-225-9400) are two of several suppliers who can furnish waterstops meeting these requirements. Approved equal materials may also be used.

2.3 JOINT SEALERS

A. Joints, not requiring waterstops or when so indicated on the Drawings, shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.

B. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall be NSF approved for use with potable water.

C. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.

E. The mastic joint sealer shall be an acceptable two-part, self-leveling (or gun grade), non-staining, polyurethane elastomeric sealant which cures at ambient temperature. Acceptable sealants shall conform to ASTM C-920 or Federal Specification TT-S-00227E.

F. For sloping joints, vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 12-1/2, or Federal Specification TT-S-0027 E(3), Type II.

G. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, or Federal Specification TT-S-0027 E(3), Type I shall be used. For joints subject to either pedestrian or

vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 25 to 35, shall be used.

H. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.

I. Acceptable polyurethane materials are PERMAPOL RC-270SL RESERVOIR SEALANT, as manufactured by PRODUCTS RESEARCH & CHEMICAL CORP., Gloucester City, New Jersey (800-257-8454), SIKAFLEX/2C POLYURETHANE ELASTOMERIC SEALANT, as manufactured by SIKA CHEMICAL CORP., Santa Fe Springs, CA (213-941-0231) and SELECT SEAL U-227 RESERVOIR GRADE, as manufactured by SPC, Upland, CA (7l4-985-577l), or approved equal.

2.4 REFORMED JOINT FILLER

A. Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

2.5 BACKING ROD

A. Backing rod shall be an extruded closed cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 BOND BREAKER

A. Bond breaker shall be SUPER BOND BREAKER WATER BASE as manufactured by Burke Company, San Mateo, California; SELECT EMULSION CURE 309, as distributed by Select Products Co., Upland, CA (clear or white pigmented) or equivalent. Fugitive dye may be used in bondbreakers if recommended by the manufacturer.

## PART 3: QUALITY ASSURANCE

3.1 WATERSTOP INSPECTION

A. It is required that all waterstop field joints shall be subject to rigid inspection, and no such work shall be scheduled or started without having made prior

arrangements with the ENGINEER to provide for the required inspections. Not less than 24 hours' notice shall be provided to the ENGINEER for scheduling such inspections. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which shall pass said inspection, and all faulty material shall be removed from the site and disposed of by the CONTRACTOR at its own expense.

B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection.

1. Offsets at joints greater than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.
2. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.
3. Any combination of offset or exterior crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16-inch or 15 percent of material thickness at any point, whichever is less.
4. Misalignment of joint which result in misalignment of the waterstop in excess of 1/2-inch in 10 feet.
5. Porosity in the welded joint as evidenced by visual inspection.
6. Bubbles or inadequate bonding which can be detected with a pen knife test. (If, while prodding the entire joint with the point of a pen knife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

3.2 WATERSTOP SAMPLES

A. Field samples of fabricated fittings (crosses, tees, etc.) may be selected at random by the ENGINEER at his discretion, for testing by a laboratory at the OWNER'S expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be furnished under this contract.

## PART 4: EXECUTION

4.1 INSTALLATION OF WATERSTOPS

A. The waterstop shall be correctly positioned in the forms so that the center of the waterstop is centered on the joint.

B. In cases where preformed expansion joint material is used in conjunction with the

waterstop, allowance shall be made for equal waterstop embedment on each side in the concrete.

C. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment.

D. Horizontal waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated.

E. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented.

F. A hog-ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.

G. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing.

H. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the waterstop, and shall be watertight.

I. PVC waterstop may be butt-spliced on the job with an electrical splicing iron. There is no crimping, shaping, brazing, or vulcanizing necessary. Elbows, tees, and crosses can also be produced by this method.

J. Connect the ends of the radial waterstop in the wall footing joints to the circumferential waterstop in the wall to wallfooting joint and to the circumferential waterstops in the floor to wall-footing joints if they should exist.

4.2 JOINT SEALERS

A. Joint sealed areas shall be sandblasted or roughened and blown clean of dust and sand with compressed air before the material may be applied.

B. Joints shall be primed (if required) and the sealant shall be applied in accordance with the manufacturer's recommendations.

**END OF SECTION 03251**

# SECTION 03300

# CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, cement, concrete materials, mix design, placement procedures, and finishes.

B. Related Sections include the following:

1. Division 3 Section “Reinforcing Steel”
2. Division 3 Section “Expansion and Construction Joints”
3. Division 3 Section “Cold Weather Concreting Procedures”
4. Division 3 Section “Hot Weather Concreting Procedures”

### 1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

### 1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mix water to be withheld for later addition at Project site.

C. Formwork Shop Drawings: Design and engineering of formwork are Contractor's responsibility.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork and shoring removal.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

F. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Cementitious materials
2. Aggregates. Provide tests per ASTM C33. Tests may be waived by Engineer if aggregates to be used have shown by actual use to produce concrete of required strength, durability, water-tightness, fire resistance and wearing qualities. Proof of satisfactory results used to waive tests of aggregates shall be less than 2 years old.
3. Form materials and form-release agents.
4. Admixtures.
5. Curing materials.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Epoxy joint filler.
10. Joint-filler strips.
11. Repair materials.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following, unless more stringent provisions are indicated:

1. ACI 301, "Specification for Structural Concrete."

2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3. ACI 211, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete"

4. Standards of the American Society for Testing and Material (ASTM) where applicable.

G. Raceway Tolerances: Construction tolerances for the interior surfaces of the concrete raceways shall be in accordance with ACI 301 modified as follows:

1. Straight, vertical or horizontal wall surfaces shall be flat planes within the following tolerances:

a. Walls and Floors: They shall be plumb within 1/8-inch in any 10 feet and within ½-inch for the entire length of the wall.

b. Depressions or Rises: In wall and floor slab surfaces, depressions or rises shall not be more than 3/16-inch when a 10 feet straight edge is placed upon the surface in any direction, or at any location.

c. Wall and Floor Thickness: These shall not be more than 3/16-inch minus, nor ½-inch plus, from the plan dimensions.

2. Any concrete work not meeting the above construction tolerances will be rejected and replaced at no cost to the Owner.

## PART 2 - MATERIALS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1, or better.
    b. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
    c. Structural 1, B-B, or better, mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.

**B. Raceway Surface Requirements:**

1. Vertical surfaces of exposed raceway walls shall be formed with steel forms only, OR with steel ply forms with the following form liner;

    a. Smooth Sheet ABS form liner, 0.070 inch thickness by Symons Dayton Superior or equal.
    b. Form liner shall be used from the base floor slab up to the fillet portion of the top of the wall. Where the wall is not flared at the top, the form liner shall be installed to the top of the wall.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal. Provide waterstops on all wall form ties.

## 2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I/II.

1. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:

1. Class: Severe weathering region, but not less than 3S.
2. Nominal Normal and Maximum Aggregate Size: 3/4 inch (19 mm).

C. Water: Potable and complying with ASTM C 94.

## 2.3 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

## 2.4 VAPOR RETARDERS

A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick:

1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils (0.25 mm) thick.
2. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mils (0.18 mm) thick.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

## 2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

E. Compatibility with Fish: Contractor shall confirm that any curing products used on raceway surfaces are compatible with fish rearing.

F. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound:

a. Spray-Cure & Seal Plus; ChemMasters.
b. UV Super Seal; Lambert Corporation.
c. Lumiseal Plus; L&M Construction Chemicals, Inc.
d. CS-309/30; W. R. Meadows, Inc.
e. Seal N Kure 30; Metalcrete Industries.
f. Rich Seal 31 percent UV; Richmond Screw Anchor Co.
g. Cure & Seal 31 percent UV; Symons Corporation.
h. Certi-Vex AC 1315; Vexcon Chemicals, Inc.

## 2.6 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:

1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.7 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows: Submit the design mixes for review at least 21 days before first use is planned. Include substantiating test data and mix design details, including aggregate gradation and source, water/cement ratio, mix proportions, air content, slump, strength and all admixtures. Substantiating data must include tests by an independent testing laboratory verifying the requirements of these specifications and shall be less than 2 years old.

1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.

B. Use a qualified independent approved testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

C. MIX 1) Water-Retaining Raceway Walls and Slabs; Proportion normal-weight concrete mix as follows:
1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
2. Maximum Slump: 4 inches (100 mm).

D. MIX 2) Exterior Slabs-on-Grade, Walks, Stoops, Stairs, Pavement Slabs: Proportion normal-weight concrete mix as follows:
1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
2. Minimum Cementitious Materials Content: 540 lb/cu. yd. (320 kg/cu. m).
3. Maximum Slump: 4 inches (125 mm).

E. MIX 3) Grout for Grout Shaping of Raceway Discharge Canals: Proportion normal-weight concrete mix as follows:
1. Compressive Strength (28 Days): 3000 psi (27.6 MPa).
2. Maximum Slump: 6 inches (125 mm).
3. Maximum Aggregate Size: ¼-inch.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.

G. Maximum Water-Cementitious Materials Ratio: 0.50 for regular concrete. (MIX 1). 0.55 for grout shaping (MIX 3).

H. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete exposed to deicers, subject to freezing and thawing while moist. This includes all concrete for MIX 2.

I. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:

1. Air Content: 5.0 percent for 1-1/2-inch- (38-mm-) nominal maximum aggregate size.
2. Air Content: 5.5 percent for 3/4-inch- (19-mm-) or 1-inch nominal maximum aggregate size.

J. All concrete for this project shall be air entrained to meet the above requirements. Air-entrainment not require for Grout Shaping (MIX 3).

K. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

L. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
1. Class B, 1/4 inch (6 mm).

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

## 3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.
2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

## 3.3 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
   1. At least 70 percent of 28-day design compressive strength.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

## 3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.

C. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.

   1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

E. Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.

   1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

## 3.5 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm) in height.

1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

## 3.6 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.

1. Apply scratch finish to surfaces indicated and to surfaces to receive grout shaping.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish:

D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to raceway floor slabs. See raceway tolerances under Quality Assurance.

E. Broom Finish: Apply a broom finish to raceway walkway surfaces, sidewalks, steps, and ramps.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

## 3.7 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Aluminum Inserts and Embeds: All aluminum materials inserted in concrete shall have the contact surface coated with bitumastic.

## 3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

## 3.9 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

## 3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

## 3.11 WATER HOLDING STRUCTURES LEAKAGE TESTING

*A. See leakage testing requirements in Special Provisions.*

## 3.12 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 20 cu. yd. but less than 45 cu. yd. plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.

    a. Test two field-cured specimens at 7 days and two at 28 days.
    b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design

compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

**END OF SECTION 03300**

# SECTION 03360

# GROUT

## PART 1: GENERAL

### 1.1 WORK INCLUDED

A. This section covers the uses of grout in the existing manholes and where indicated on the Drawings.

### 1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Supplementary Conditions.
   1. Manufacturer's information indicating the application, formulation, and installation procedures for each brand and type of grout to be used.

### 1.3 PRODUCT HANDLING

A. Delivery of Materials. The Contractor shall deliver all materials to the job site in original, new and unopened containers bearing the manufacturer's name and label showing at least the following information:
   1. Name or title of the material;
   2. Federal Specification number, if applicable;
   3. Manufacturer's stock number;
   4. Manufacturer's name;
   5. Contents by volume for major constituents;
   6. Handling instructions; and
   7. Application instructions.

B. Storage of Materials. The Contractor shall provide proper storage to prevent moisture contamination of, damage to, and deterioration of grout materials.

C. Protection. The Contractor shall use all means necessary to protect the materials in this section before, during, and after installation to protect the work and materials of all other trades.

## PART 2: MATERIALS

2.1 NON-SHRINKING GROUT

A. Non-shrinking grout shall be Sika Grout 212, or equal.

2.2 EPOXY GROUT

A. Adhesive: Two-component liquid equal to Thermal-Chem "Mortar Resin Product No. 3," Minwax "Por-Rok Epoxy Grout."

B. Aggregate: As recommended by the epoxy grout manufacturer.

2.3 QUICK SETTING HYDRAULIC CEMENT

A. Quick setting hydraulic cement shall be SikaSet Plug, or equal.

2.4 WATER

A. Clean and free from deleterious substances.

## PART 3: EXECUTION

3.1 NON-SHRINKING GROUT

A. General. Non-shrinking grout shall be furnished factory-premixed so only water is added at the job site. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

B. Preparation. The concrete foundation to receive non-shrinking grout shall be saturated with water for 24 hours prior to grouting.

C. Placement. Grout shall be placed in strict accordance with the directions of the manufacturer so all spaces and cavities below the top of baseplates or against existing concrete slabs or walls are completely filled without voids. Forms shall be provided where structural components of baseplates or launders will not confine the grout.

D. Finishing. The grout shall be finished smooth in all locations where the top surface or edge of the grout will be exposed to view after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

E. Curing. Non-shrink grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet-cured for at least 7 days.

## 3.2 EPOXY GROUT

A. General. Components shall be packed separately at the factory and field mixed. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

B. Preparation. Where indicated on the Drawings, anchor bolts and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be 1/4-inch larger than the maximum dimension of the bolt head, and 1/2-inch larger than the bar diameter. The embedment depth for epoxy-grouted anchor bolts and reinforcing bars shall not be less than 10-bolt or bar diameters unless indicated otherwise on the Drawings.

1. Holes shall be prepared for grouting as recommended by the grout manufacturer.

C. Installation. Anchor bolts and reinforcing bars shall be clean, dry, and free of grease or other foreign matter at the time of installation. The bolts and bars shall be set and positioned and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to insure that all spaces and cavities are filled with epoxy grout, without voids.

## 3.3 QUICK SETTING HYDRAULIC CEMENT

A. General. Contents shall be packaged at the factory and mixed with water in the field to obtain the desired consistency. Proportioning and mixing shall be in accordance with the manufacturer's recommendations.

B. Preparation. The concrete area to receive quick setting hydraulic cement should be thoroughly cleaned and lightly dampened just prior to application.

C. Installation. The quick setting hydraulic cement shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to insure that all spaces and cavities are filled without voids.

3.4 USES OF GROUT

A. Non-shrink grout shall be used beneath all equipment bases and other locations shown on the Drawings or specified herein. Grouting thicknesses and application shall meet the equipment manufacturer's requirements.

B. Epoxy grout shall be used at locations shown on the Drawings or specified herein. Repair of rock pockets or surface defects in concrete work approved for repair by the Engineer shall generally be repaired with epoxy grout unless otherwise directed by the Engineer. Anchor bolts approved by the Engineer for installation in concrete shall be set in epoxy grout unless otherwise directed by the Engineer. This grout shall not be used in contact with potable water.

C. Quick setting hydraulic cement shall be used at locations shown on the Drawings or specified herein. All penetrations/joints in concrete manholes, vaults, or structures where a watertight seal is required shall use this type of grout.

**END OF SECTION 03360**

**SECTION 05500**

**FABRICATED METAL WORK AND CASTINGS**

## PART 1: GENERAL

### 1.1 DESCRIPTION

A. This section covers the work necessary to furnish and install fabricated metal work and castings as shown, or as required to secure various parts together and provide a complete installation. Included in this section are the rock (debris) basket and wet well access hatch at the fish waste pump station.

### 1.2 SUBMITTALS

A. Complete submittals, including materials specifications, and dimensional drawings portraying the assembled structure(s) shall be provided in accordance with the requirements of Section 01610 – General Equipment Stipulations. Additionaly the following shall be provided:

1. Product Data: Furnish the following:
   a. Expansion Anchors: ICBO or other similar code organizations' recommendations regarding safe allowable design loads.
   b. Adhesive Anchors: ICBO evaluation report for anchoring threaded rods into stone aggregate concrete.
   c. Assembly, Installation and Anchorage Instructions: Furnish for all materials and products used, including factory-fabricated metal work.
2. Shop drawings and dimensional drawings for all factory- and field-assembled metal work, including any floor or concrete openings required to accommodate metal work assemblies.
3. Manufacturer’s rated loading criteria for hoisting equipment, stairways, and other load-bearing assemblies.
4. Samples: Furnish the following:
   a. Adhesive Anchors: Two self-contained adhesive cartridges for each batch of adhesive delivered to project site, for independent testing.
5. Quality Control Submittals:
   a. Adhesive Anchors: Furnish the following:
      1. Manufacturer's past project experience data on at least three similar projects supplied with proposed system within the last three years, to include client name, address, contact person, phone number, project location, and description of work.
      2. Test reports for each batch of adhesive delivered to site. Provide manufacturer's written certification that each batch delivered meets these Specifications, the intended uses on project, and capability to bond to damp or wet concrete

surfaces.

3. Manufacturer's written letter of certification identifying contractor employees qualified for installing adhesive anchors, trained through jobsite instruction conducted by manufacturer.
4. Furnish specific written statement from EPA and health agencies that the adhesive product is acceptable for use in potable water structures or conveyances prior to use on this project.

b. All Concrete Anchors: Provide specific instructions or all phases of installation including hole size, preparation, placement, and procedures. Provide also specific instructions for safe handling and installation of all anchors to Contractor staff handling and installing these anchors.

c. Welder Certifications for all welders field-assembling fabricated metal work.

## 1.3 QUALITY ASSURANCE

A. Qualifications: Qualify welding operators in accordance with requirements of current AWS Standard Qualification Procedure D1.1, Chapter 5.
   1. Qualification Tests: Performed by a recognized testing laboratory.

B. Certification: Certify welders of structural and reinforcing steel for all positions of welding in accordance with such procedure.

## 1.4 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
   1. Insofar as practical, factory assemble items specified herein.
   2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.
   3. Prior to shipment, plastic shrink-wrap unprimed ferrous metal work or prime with zinc-rich primer. Handle items to maintain the integrity of corrosion protective wraps and coatings.

B. Storage of Adhesive Products:
   1. Store components on pallets or shelving in a covered storage area with locking door.
   2. Control temperature within 41E F to 77E F and dispose of product if shelf life has expired.
   3. If stored at temperatures above manufacturer's recommended maximum, test components prior to use to determine if they still meet specified requirements.

## PART 2: MATERIALS

2.1 GENERAL

A. Like Items of Materials: End products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

B. Lifting Lugs: Provide on equipment and equipment components weighing over 100 pounds.

C. Furnish miscellaneous items:
1. Miscellaneous metal work and castings as shown, or as required to secure various parts together and provide a complete installation.
2. Items specified herein are not intended to be all-inclusive. Provide metal work and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.

D. Unless otherwise indicated, materials shall meet the latest issue of ASTM Specifications as follows:

| Item | ASTM Specification |
|---|---|
| Steel Shapes & Plates | A36 |
| Steel Pipe Columns | A501 or A53, Type E or S, Grade B |
| Structural Steel Tubing | A500, Grade B |
| Stainless Steel: | |
| Bars & Shapes | A276, Type 304 |
| Steel Plate, Sheet & Strip | A167, Type 304 |
| Bolts | A193, Type 304, B8MN, B8M2, or B8M3 |
| Nuts | A194, Type 304, B8MN, B8M2, or B8M3 |
| Aluminum, Structural Shapes & Plates | Alloy 6061-T6, meeting referenced specifications & ASTM sections found in Aluminum Association current Construction Manual Series |
| Connection Bolts for Steel Members; Use Compres-sible-Washer Type Direct Tension Indicators @ All Connections; Use Hardened Washers also Under Head and Nut Anchor Bolts and Nuts: | A325-F, F436 (Washers) |
| Carbon Steel | A307 or A36 |

| | |
|---|---|
| Stainless | A193, Type 304 |
| Galvanized Steel Bolts and Nuts | A153, Zinc Coating for A307 or A36 |
| Flat Washers (Unhardened) | F844, Use 153 for Zinc Coating |
| Threaded Bars | A36 |

Connection Bolts for Wood Members:

| | |
|---|---|
| Dry Environment | A307 Uncoated |
| Wet Use or Exterior Use | A307 w/A153 Galvanizing |
| Connection Bolts for Aluminum | A2024-T4; or Use Appropriate Stainless Steel |
| Cast Iron | A48, Class 30 |

## 2.2 ANCHOR BOLTS

A. Non-submerged Use:
   1. Galvanized Steel: For equipment and machinery, where permanently anchored into concrete, unless otherwise shown.
   2. Diameter, Length, and Bend Dimensions: As required by equipment or machinery manufacturer. Unless otherwise required by calculations for seismic or other loadings, provide 5/8-inch minimum diameter and other geometry as shown.
   3. Furnish minimum two nuts and a washer of same material for each bolt.
   4. Provide sleeves as required or as shown for location adjustment.

B. Submerged Use:
   1. Submerged use is defined as any connection below a point 1 foot 6 inches above maximum water surface elevation in a water holding basin.
   2. As specified for non-submerged use, for anchoring equipment, machinery or other connection except as follows:
      a. 316 stainless steel.

C. For anchoring fabricated metal work or structural building columns, or other components where connections will be protected or dry:
   1. Galvanized steel.
   2. Minimum Size: 5/8-inch diameter by 12-inch long, unless otherwise shown or required by calculations.
   3. Furnish two nuts and one washer per bolt of same material as bolt, unless otherwise shown.

D. For anchoring fabricated metal work or structural building, or structural frame components in areas of wet use, wash down areas, or areas outside heated buildings:
   1. Galvanized steel.
   2. Minimum Size: 5/8-inch diameter by 12-inch long, unless otherwise shown

or required by calculations.

3. Furnish two nuts and one washer per bolt of same material as bolt, unless otherwise shown.

## 2.3 ANCHOR BOLT SLEEVE

A. Fabricated Steel Sleeve:
   1. Material: A36 steel.
   2. Dimensions, welding, and sizes as shown.

## 2.4 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Provide for stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners.

B. Lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper as manufactured by:
   1. Loc Tite Co., Permatex.
   2. Or equal.

## 2.5 ANCHORING SYSTEM FOR CONCRETE

A. Expansion Anchors:
   1. Self-drilling anchors, snap-off type or flush type.
   2. Provide anchors in Type 316 Stainless Steel (all storage tank applications) and hot-dipped galvanized (all other applications). Expansion anchors shall not be used for submerged applications.
   3. Non-drilling Anchors: Flush type for use with bolt or stud type with projecting threaded stud.
   4. Provide in dry areas only where future corrosion is not a problem unless expansion anchors are 316 stainless steel.
   5. In wet or damp areas, provide wedge anchors as specified, or in submerged conditions, adhesive anchors as specified.
   6. Manufacturer:
      a. ITT Phillips Drill Div., Michigan City, IN.
      b. Hilti, Inc., Tulsa, OK, Hilti HDI Drop-In Anchors.

B. Adhesive Anchor Systems:
   1. Provide for anchoring metal components at or below a point 1 foot 6 inches above maximum water surface elevation in water-holding structures, or buried in earth conditions. Do not use where fire or elevated temperatures can occur.
   2. Two-component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.

3. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
4. Container Markings: Include manufacturer's name, product name, batch number, product expiration date ANSI hazard classification, and appropriate ANSI handling precautions.
5. Mixed Adhesive: Manufacturer to submit current test data indicating cured adhesive meets or exceeds design loads required.
6. Storage of Adhesive Products:
    a. Store components on pallets or shelving in a covered storage area with locking door.
    b. Control temperature to within 41E to 77E F and dispose of product if shelf life has expired.
    c. If stored at temperatures above manufacturer's recommended maximum, test components prior to use to determine if they still meet specified requirements.
7. Anchor Rods:
    a. Threaded Rods: Sized for design loads required and adhesive system used, by adhesive manufacturer:
        1) ASTM A193, Type 316, stainless steel.
8. Manufacturers:
    a. HIT Doweling Anchor System (HIT C-100), by Hilti, Inc., 5400 South 122 East Avenue, Tulsa, OK 74146; (918) 252-6000.
    b. Or equal.

## 2.6 BOLTS AND FASTENERS

A. Type 316 stainless steel as specified if not permanently embedded in concrete, but located in areas as follows:
1. Outdoors in areas subject to the weather.
2. Chemical handling areas.
3. Equipment rooms subject to drainage, leakage, and washdown.
4. In galleries and trenches.

B. ASTM A307 or A36 with ASTM A153 galvanized if not permanently embedded in concrete, and not used for structural steel or piping, but located indoors where wash down, leakage, and drainage are not likely to occur (e.g., in personnel buildings excluding laboratories, on motor floors, in electrical equipment rooms, and in control rooms).

C. For Flanges of Piping, Valves, and Other Similar Connections: As specified in other sections, or as shown.

2.7 LOOSE STEEL LINTELS AND ANGLE FRAMING

A. Provide as required for support of construction not attached to structural steel framing or where not specified elsewhere.

B. Shop prime in accordance with Section 09900.

2.8 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 9 painting Sections.

C. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.9 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

2.10 GRATING SUPPORT ANGLES

A. Fabricate to sizes shown. Hot Dip Galvanize after Fabrication. Where indicated on four sides fabricate with miter-cut corners, butt welded. Where indicated on two sides, fabricate with end closure plates.

2.11 SHOP PAINTING

A. Clean ferrous metal items not galvanized and apply shop coat of metal primer.

**PART 3: EXECUTION**

3.1 FABRICATION

A. General:
   1. Exposed Surfaces Finish: Smooth, sharp, well-defined lines.
   2. Provide necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.

3. Conceal fastenings where practical.
4. Drill metal work and countersink holes as required for attaching hardware or other materials.
5. Fabricate materials as specified.
6. Weld connections, except where bolting is directed.
7. Methods of fabrication not otherwise specified or shown shall be adequate for stresses and as approved.
8. Grind exposed edges of welds smooth on walkways, guardrails, handrails, stairways, channel door frames, steel column bases, and where shown.
9. Round sharp edges to 1/8-inch minimum radius. Grind burrs, jagged edges, and surface defects smooth.

B. Aluminum:
1. Fabricate as shown, and in accordance with the Aluminum Association Standards and manufacturer's recommendations as approved.
2. Grind smooth sheared edges exposed in finished work.
3. All aluminum in contact with concrete or grout shall be coated with two coats of Coal Tar Epoxy, 10 mil minimum dry film thickness per coat.

## 3.2 WELDING

A. General:
1. Meet codes for Arc and Gas Welding in Building Construction of the AWS and AISC for techniques of welding employed, appearance, quality of welds made, and the methods of correcting defective work.
2. Welding Surfaces: Free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain.
3. A light film of linseed oil may likewise be disregarded.
4. Do not weld when temperature of base metal is lower than 0E F.
5. Finished members shall be true to line and free from twists.
6. Prepare welds and adjacent areas such that there is:
   a. No undercutting or reverse ridges on the weld bead.
   b. No weld spatter on or adjacent to the weld or any other area to be painted.
   c. No sharp peaks or ridges along the weld bead.
7. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

B. Welding Operators: As specified in PART 1, Article QUALITY ASSURANCE.

C. Aluminum:
1. Weld with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) processes in accordance with manufacturer's written instruction as approved, and in

accordance with recommendations of the American Welding Society contained in the Welding Handbook, as last revised.

2. Grind smooth all exposed aluminum welds.

## 3.3 INSTALLATION OF FABRICATED METAL WORK

A. General:

1. Install in accordance with shop drawings, the Drawings, and these Specifications.
2. Install fabricated metal work plumb or level as applicable.
3. Completed installations shall be rigid, substantial, and neat in appearance.
4. Erect structural steel in accordance with applicable portions of AISC Code of Standard Practice, except as modified.
5. Install commercially manufactured products in accordance with manufacturer's recommendations as approved.

B. Aluminum:

1. Erection: In accordance with the Aluminum Association.
2. Do not remove mill markings from concealed surfaces.
3. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.

## 3.4 ANCHOR BOLTS

A. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

## 3.5 CONCRETE ANCHORS

A. Do not begin installation until concrete or masonry receiving anchors have attained design strength.

B. Do not install an anchor closer than six times its diameter to either an edge of concrete or masonry, or to another anchor, unless specifically shown otherwise.

C. Install in accordance with manufacturer's specific quality control submittal instructions specified hereinbefore. Use manufacturer's recommended drills and equipment. Hole diameters are critical to installation, use only drills recommended by anchor manufacturer. Follow manufacturer's safe handling instructions.

D. Follow specific manufacturer safe handling practices when handling and/or installing all concrete anchors.

3.6 STAINLESS STEEL FASTENERS LUBRICANT (ANTI-SEIZING)

A. Apply specified anti-seizing lubricant to threads prior to making up connections.

3.7 ELECTROLYTIC PROTECTION

A. Aluminum:
   1. Where in contact with dissimilar metals, or in contact with concrete or grout, protect with two coats of Coal Tar Epoxy, 10 mil minimum dry film thickness per coat.
   2. Allow paint to dry before installation of the material.
   3. Protect painted surfaces during installation.
   4. Should coating become marred, prepare and touch up per paint manufacturer's written instructions.

B. Where titanium equipment is in contact with concrete or dissimilar metals, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70 durometer hardness.

3.8 FIELD PAINTING

A. Prepare surfaces and apply primer in accordance with paint manufacturer's printed directions as approved, utilizing appropriate painting system.

**END OF SECTION 05500**

# SECTION 16005

# ELECTRICAL

## PART 1: GENERAL

### 1.1 DESCRIPTION

A. This section covers all electrical work as indicated on the drawings.

B. The work, in general, consists of, but is not limited to, providing:

1. Installation of a new electrical service.
2. Electrical feeds to new and existing buildings.
3. Conduit and wiring for all outlets and equipment shown.
4. Lighting fixtures and Area Lighting.
5. Lightning and Surge Protection Equipment.
6. Motor Control.

### 1.2 SUBMITTALS

A. The following submittals for construction shall be made in accordance with the project submittal requirements as described in the Submittals Specification Section and the Supplementary Conditions.

1. Complete manufacturer's descriptive information and shop drawings for all equipment, material, and devices furnished under this Section, including certified outline drawings, arrangement drawings, elementary (schematic) diagrams, panel elevation drawings, interconnection and connection wiring diagrams.
2. Manufacturers' installation instructions and Operation and Maintenance Manuals for electrical equipment and fixtures as specified herein.

### 1.3 ELECTRIC UTILITY SERVICE

A. Contractor shall be responsible for power service on the Customer side of the transformer.

B. Contractor shall be responsible for providing any new power services indicated in the Drawings. This includes all costs, work, and coordination required with the utility provider.

C. Contractor shall be responsible for all temporary power needed at construction sites.

D. All materials and work shall meet the requirements of the utility provider, the current edition of the National Electric Code (NEC), and any applicable state and local codes.

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for:

B. Complete systems in accordance with the intent of these Contract Documents.

C. Coordinating the work required under all Sections of this Specification that affect the work covered in this section. This effort is required to assure that the project construction proceeds in an appropriate and timely manner.

D. Furnishing and installing all incidental items not actually shown or specified, but which are required by code or good practice to provide complete functional systems.

1.5 INTENT OF DRAWINGS

A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceways, final sizing of conductors, and location of equipment and connections.

B. The control diagrams for the equipment are diagrammatic and intended to show the desired operation. The Contractor shall install exactly as shown unless this operation will cause failure of the equipment due to unique operating characteristics of the supplied equipment not known to the Engineer.

C. The contractor shall notify the Engineer of such conflicts within 30 days of the Contract award and receive written resolution before proceeding with the Contract work. Any damage to the Contractor-supplied equipment arising due to improper control shall be the responsibility of the Contractor.

1.6 CODES, PERMITS, AND REGULATIONS

A. All work shall be performed in strict accordance with the current edition of the Local Laws and Ordinances, National Electrical Code (NEC), National Electrical Safety Codes (NESC), and the Occupational Safety and Health Act. (OSHA). Conflicts, if any, that may exist will be resolved at the discretion of the Engineer.

B. Wherever the requirements of the Specifications or Drawings exceed those of these codes, the requirements of the Specifications or Drawings shall govern. Code

compliance is mandatory. Nothing in the Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

C. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over this work. Upon completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.7 WARRANTY

A. The materials, equipment and workmanship specified herein shall be guaranteed to the Owner against defects for a period of 1 year from the date of completion of the improvements, not to exceed 24 months from the date of shipment. In the event that the materials and equipment installed fails to perform as specified, the contractor shall promptly repair or replace the defective items without cost to the Owner, including handling and shipping costs.

## PART 2: MATERIALS

2.1 GENERAL

A. Unless otherwise indicated, provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment listed by UL wherever standards have been established by that agency. No used equipment shall be allowed.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

2.2 STANDARD PRODUCTS

A. Unless otherwise indicated, provide materials and equipment that are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

2.3 EQUIPMENT FINISH

A. Provide materials and equipment with manufacturers' standard finish system unless otherwise noted. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI NO. 61, light gray color.

## 2.4 OUTDOOR EQUIPMENT

A. Equipment and devices to be installed outdoors or in unheated enclosures shall be capable of continuous operation within an ambient temperature range of minus 20° F to 104° F.

## 2.5 HAZARDOUS AREAS

A. Provide materials and equipment acceptable to the regulatory authority having jurisdiction for the Class, Division, and Group of hazardous area indicated.

## 2.6 SERVICE ENTRANCE AND METER/MAINS

A. Service Entrance shall be as indicated on the Drawings, conforming to the requirements of the utility provider, and national and local electrical codes. Shop drawings shall be submitted to the Engineer and, at the Engineer's option, to the power company for approval.

B. New or replacement service entrances up to 1200 amp rating, where indicated on the Drawings, shall be of the meter/main type, incorporating both a meter and main disconnect. Contractor shall provide current transformer can, 200A jaw meter socket and landing lug. Meter/mains shall include 1200A main disconnect for 480VAC, 3-phase service. Meter/mains shall include lockable NEMA 3R enclosures.

## 2.7 MOTOR CONTROL, GENERAL

A. Provide each motor with a suitable controller and devices that will function as specified for the respective motors. Motor horsepower ratings and enclosures shown are what is expected. Ratings are for guidance only and do not limit the equipment size. When motors furnished by the Contractor differ from the expected ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed.

B. Motor starters shall be furnished with adequate NO and NC auxiliary contacts to accomplish the control, status indication, and telemetry functions indicated in the Drawings and Specifications. Where auxiliary contacts are not required for the Work, furnish starters with integral spaces for future addition of such contacts.

C. Each motor shall have solid state thermal overload protection. This protection shall have 3:1 adjustment for trip current protection and LED power indication. Overloads shall be ambient sensitive, self-powered, and mounted within the motor controller. All overload protection devices shall be the inverse time limit type.

D. The Contractor shall select and install overload protection after the actual nameplate full-load current rating of the motor has been determined.

E. Supply individual control power transformers where indicated. The transformers shall have sufficient capacity to serve the connected load and limit voltage regulation to 10 percent during contact pick up. Fuse one side of the secondary winding and ground the other side.

F. Control wiring shall have permanent sleeve type markers applied to all wires. Minimum wire size shall be 14 AWG copper.

## 2.8 LIGHTING AND POWER DISTRIBUTION PANELBOARDS

A. Panels shall meet standards established by UL 67, NEMA PB1 and the NEC.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

C. Rating. Applicable to a system with available short-circuit current of 10,000 amperes RMS symmetrical at 208Y/120 or 240/120 VAC.

D. Bus Bars. Copper, full sized throughout length. Neutral shall be insulated and rated the same as the phase bars with at least one terminal screw for each branch circuit. Ground shall be copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit. Lugs and connection points shall be suitable for either copper or aluminum conductors, subfeed or through-feed lugs. Solderless main lugs for main, neutral and ground bus bars.

E. Panelboards shall be of the slot-size shown on the Drawings. Breakers or the ratings shown shall be included, except where "Space" is indicated.

F. Building branch circuit panelboards shall be the plug-on circuit breaker type.

G. The panels shall be provided with locking door latch. All locks shall be identically keyed, with two milled keys for each lock. Provide a typewritten sheet installed inside the door of each panel, identifying the use of the branch circuits. Panels shall be furnished with ground bus.

## 2.9 CIRCUIT BREAKERS

A. Furnish thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of the operating handle. All panelboard circuit breakers shall be bolt-on type. Do not use single-pole circuit breakers with handle ties where multi-pole circuit breakers are indicated. Use multi-pole circuit

breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting requirements of the UL 489 and NEMA AB 1.

B. Do not use tandem or dual circuit breakers in normal single pole spaces.

2.10 MAIN CIRCUIT BREAKER

A. Provide static trip circuit breaker in accordance with NEMA AB 1 and UL 489 and UL labeled as suitable for service entrance.

B. Molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.

C. Solid-state current control with adjustable ampere setting, adjustable long-time delay, adjustable short-time trip and delay band, fixed instantaneous trip set at 15 times current sensor rating and adjustable ground fault trip and delay band.

D. Setting adjustments to be covered by a sealable, tamper-proof, transparent cover.

E. Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in an emergency situation.

F. Minimum Interrupt Rating: 42,000 amps RMS symmetrical at 480 VAC.

G. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

H. Locking. Provisions for padlocking handle.

I. Enclosure. NEMA 250, Type 12.

J. Interlock. Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

2.11 SAFETY SWITCHES

A. Safety switches shall be quick-make, quick-break, motor rated, load-break, fusible where specified, heavy-duty type with external markings clearly indicating ON/OFF positions.

B. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

C. Enclosures. NEMA 12 for indoor installation or NEMA 3R rain-tight for outdoor installations.

D. Interlock. Enclosure and switch to prevent opening cover with switch in the ON position.

## 2.12 CONDUITS

A. Rigid Galvanized Steel (RGS) or Intermediate Metal Conduit (IMC). Use rigid steel or intermediate metal conduit, including threaded type couplings, elbows, nipples, and other fittings, galvanized by hot dipping, electroplating, or metalizing process and meeting the requirements of ANSI C80, NEMA FB 1, UL 6, and the NEC.

B. Electric Metallic Tubing (EMT). Use electric metallic tubing, which is zinc-coated, enamel-lined and threadless, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of ANSI C80, NEMA FB 1, UL 797, and the NEC.

C. PVC Conduit. Use rigid PVC Schedule 80 conduit, UL listed for concrete encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90° C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL 651, NEC, and ASTM specified tests for the intended use.

D. Flexible Metal Conduit, Liquid-tight. Use UL 360 listed for 105 degrees C insulated conductors, conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring. Fittings and conduit bodies shall meet the requirements of NEMA FB 1.

E. Flexible Conduit, Non-liquid-tight. Use non-liquid-tight flexible steel conduit tubing, consisting of hot-dipped galvanized or electrogalvanized, inside and outside, made in one continuous length of spirally-wound steel strip with uniform interlocking convolution meeting the requirements of UL-1, or any subsequent revisions. Fittings and conduit bodies shall meet the requirements of NEMA FB 1.

## 2.13 CONDUCTORS

A. All conductors shall be copper. Provide stranded conductors except provide solid conductors where No. 10 AWG and No. 12 AWG are used for branch circuit power wiring in lighting and receptacle circuits.

B. Wire sizes No. 8 AWG and smaller shall have a thermoplastic PVC insulation with an overall nylon jacket. Stranded wire shall be Class C stranded. The conductor shall be rated THHN/THWN.

C. Wire sizes larger than No. 8 AWG shall be non-organically filled cross-linked polyethylene insulation Type XHHW, or have thermoplastic PVC insulation with an overall nylon jacket rated THHN/THWN.

D. Cords shall be type SEOW, American Insulated Wire Corp., Coleman Cable Co Seoprene 105, or approved equal.

E. Multi-Conductor Cable: Provide cables as specified under the following Type numbers.

1. Type 1 (600 Volt Multi-Conductor Control Cable, Type TC)
   a. General.
      1) Multi-conductor control circuit interconnection cable with ground. Suitable for installation in open air, in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.
      2) Individual conductors.
      3) No. 14 AWG, 19 strand copper.
      4) Insulation and Jacket.
      5) Each conductor shall have 15-mil PVC insulation with THHN-THWN legend. Conductor group shall be color-coded in accordance with ICEA method 1, Table K2, and shall include one full size green grounding conductor. Group shall be bound with a spiral wrap of barrier tape. Jacket shall be flame retardant and sunlight and oil resistant PVC.
      6) Provide 5-, 7-, 12-, 25-, conductor cable as required, including a green grounding conductor.
      7) Manufacturer and type:
         a) Okonite FMR-Okoseal Type TC; Cablec Corp. XLPE Control Cable Type TC; or equal.
2. Type 2 (600 Volt Multi-Conductor Power Cable, Type TC)
   a. General.
      1) Three or four conductor, with ground and overall jacket. Suitable for installation in open air, in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.
   b. Individual Conductors.
      1) Class B stranded per ASTM B-8. Size as shown.
   c. Insulation and jacket.
      1) Each phase conductor shall be insulated with chemically crosslinked polyethylene, or ethylene propylene, meeting type XHHW, VW-1 requirements of Underwriters Laboratories. Jacket shall be flame retardant and sunlight and oil resistant

Hypalon.

d. Manufacturer and type.

1) Okonite-FMR Okolon; B/W Cable Systems Inc. Pyronot II; or equal.

3. Type 3 (600 Volt No. 16 AWG Twisted, Shielded Pair Instrumentation Cable, Type TC).

a. General.

1) Single pair instrumentation cable designed for noise rejection for process control, computer, or datalog applications. Suitable for installation in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.

c. Individual Conductors.

1) No. 16 AWG Soft annealed copper, Class B, seven strand concentric per ASTM B 8. Size 20 AWG tinned copper drain wire.

d. Insulation and Jacket.

1) Each conductor shall have 15 mil PVC insulation. Jacket shall be flame retardant and sunlight and oil resistant PVC with 35 mils nominal thickness. Shield shall be 0.35 mil aluminum/mylar overlapped to provide 100 percent coverage.

e. Manufacturer and type.

1) Okonite Okoseal-N P-OS; Belden No. 9342; or equal.

F. Equipment Grounding Conductors.

1. Provide stranded copper conductors with green insulation, size as required by NEC for equipment grounding.

G. Service Grounding Conductors.

1. Provide bare solid or stranded copper, size as required by NEC for service grounding.

## 2.14 TERMINAL BLOCKS

A. Provide terminal blocks for termination of all control circuits leaving or entering equipment, panels, or boxes. Terminal blocks shall be UL 1059, compression screw clamp type with current bar providing direct contact with wire and yoke. Yokes and clamping screws shall be zinc-plated hardened steel. Individual terminals shall be rail mounted to create a complete assembly. Units shall be UL approved, CSA certified, and rated for 600V ac and currents as required. Marking system shall permit use of preprinted or field-marked tags.

## 2.15 CONTROL RELAYS

A. Time Delays and Relays: All time delays shall be of plug-in construction, industrial rated with contacts rated for 3 amps resistive min. at 240 VAC, with two Form-C contacts (minimum). Time Delays shall switch selectable ranges from .1-1s, 1.2-60, 12-600 seconds with a repeat accuracy of ±2 percent. Time Delays shall have both "timing" and "timed" LED indicators. Time delays and relays shall be IDEC series GT5Y and RY4s or approved equal.

B. Where latching (mechanically held) relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing easy manual latching and unlatching.

## 2.16 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, provide heavy-duty, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices. Contact Rating, NEMA ICS 2, Type A600.

B. Indicating lights shall be 120 volt, Push-to-Test, transformer type, with colors shown in the drawings. Utilize General Electric Type CR 104P, Cutler-Hammer type PB1, or equal.

C. Selector Switch Operating Lever: Standard.

## 2.17 ELAPSED TIME METERS

A. Elapsed Time Meters: Provide synchronous-motor-driven, elapsed time meters, 0 to 99,999.9 hours range, non-reset type, suitable for semi-flush, panel mounting. Provide Crompton Type 15; Eagle Signal Bulletin 705 unit, or equal.

## 2.18 LIGHTING FIXTURES

A. Provide fixtures with proper hangers, pendants, canopies, concrete bases, lamps, and ballasts necessary for complete installation. Use only UL listed luminaires.

B. Ballasts for fluorescent fixtures shall be of the low (ambient) temperature type.

C. Lighting fixtures shall be of the brand and model listed in the Fixture Schedule(s) on the Drawings, or equal, subject to the requirements for Submittal review.

## 2.19 RECEPTACLES

A. Provide UL listed, ground fault interrupted (GFI) receptacles meeting NEMA WD 1 performance standards. Use two-pole, three-wire grounding type receptacles rated 20 amps, 125 volts, NEMA Configuration 5-20R and with screw type wire terminals suitable for No. 10 AWG. Provide phenolic composition bases colored ivory. Provide Hubbell GF5352, or equal.

B. Provide special receptacles of the type, rating, and number of poles indicated or required for anticipated purpose.

## 2.20 SWITCHES

A. ON/OFF Snap switches. Provide UL listed, specification grade, totally enclosed, AC type, quiet tumbler switches meeting NEMA WD 1 performance standards, and capable of control of 100 percent tungsten filament and fluorescent lamp loads. Use switches rated at 20 amps, 120/277 volts unless otherwise noted. Provide phenolic operating handles colored ivory. Use switches with screw terminals.

B. Photocell switches. Provide heavy duty specification grade photoelectric cell for day/night lighting control. Outdoor weatherproof unit required with built-in delay to prevent false cycling. Switches are to mount in standard ½" knockout; 1800 watt, 120 volt, minimum. Provide Intermatic model K4021C, or equal.

## 2.21 BOXES

A. Provide boxes not less than 2 inches deep, unless shallower boxes are required by structural conditions. Do not use box extensions to provide wiring space required by the NEC. For hollow masonry construction, provide boxes of sufficient depth so that conduit knockouts or hubs are in the masonry void space.

B. For hand holes, use reinforced cast concrete boxes sized to provide adequate working space as required by standard procedures and the NEC. Provide boxes and covers for traffic loading where required.

## 2.22 COVER PLATES

A. Provide plates fitting closely and tightly to the box on which they are to be installed. On surface mounted boxes, provide plates that do not extend beyond the sides of the box unless the plates do not have sharp corners or edges.

B. Provide ivory one piece with smooth exterior faces and with oval head metal mounting screws of a color matching that of the plate.

C. Where weatherproof devices are indicated, provide a gasketed, weatherproof, cast metal coverplate and stainless steel mounting screws.

D. For concrete handholes, provide galvanized steel or cast iron, bolt on coverplate with stainless steel bolts. Engrave or burnweld before galvanizing to read "ELECTRIC," or as otherwise shown on the Drawings.

2.23 DRY TYPE TRANSFORMERS (0 TO 600 VOLTS)

A. Provide self-cooled, two-winding, UL listed, dry type transformers of the ratings indicated on the Drawings, and built in accordance with the latest IEEE, UL, ANSI, and NEMA standards. Utilize units with manufacturer's standard insulation class and standard temperature rise. For ratings 0 to 30 kVA, provide units with core and coils completely encapsulated and for units rated at 37.5 kVA and larger core and coils varnish impregnated.

B. Enclosures. For ratings 0 to 30 kVA, NEMA 250, Type 3R, nonventilated. For units rated at 37.5 kVA and larger, NEMA 250, Type 2, ventalated.

C. On all transformers 3 kVA and larger provide units with at least four, 2-1/2 percent, full-capacity voltage taps; two above and two below normal voltage rating.

D. For transformers 20 kVA and larger, equip units with integral vibration isolators completely isolating the core and coil assembly from the transformer enclosure. For smaller transformers, provide integral vibration isolators or install external vibration isolators which isolate the entire unit from the structure on which it is mounted. Utilize only integral or external vibration isolators which are rated for the weight of the transformer and provide 99 percent isolation efficiency at the fundamental frequency of sound emitted by the transformer.

E. Provide transformers manufactured by Cutler-Hammer, General Electric, Square D, or equal.

2.24 WARNING TAPE

A. Provide heavy gauge, red plastic tape of 3 -inch minimum width for use in trenches containing electric conduits or circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: Klein No. 58003, ITT Blackburn Type RT; Griffolyn Terra Tape; or equal.

2.25 TRANSIENT VOLTAGE SURGE SUPPESSION (TVSS) PROTECTION

A. Units shall be suitable for the service voltage and configuration (phases and wires)

shown.

B. Protection modes.

1. Normal, differential, and common.
2. Bipolar or bi-directional.

C. Ratings. Short-circuit current rating shall equal or exceed that of protected distribution equipment. Surge Voltage Rating (SVR) shall not exceed those specified under UL 1449 for the associated nominal system voltage. Maximum Allowable Continuous Operating Voltage (MCOV) shall be at least 115 percent of the nominal system voltage.

D. Unit shall be UL listed and be suitable for use in service entrance locations.

E. Provide status indicators for unit ON-LINE and unit operation NORMAL.

F. Provide common alarm contact output and audible alarm with enable/disable switch.

G. TVSS unit shall be mounted within the Main Switchboard or remotely located in a separate unit with a minimum enclosure rating of NEMA 12 for indoor and NEMA 3R for outdoor locations.

2.26 OTHER ENCLOSURES

A. Other electrical enclosures for outdoor applications shall be NEMA Type 4, with gasketed, lockable covers. Outdoor enclosures shall be Hoffman Type 4 CHNF with lock kit, or equal.

B. Other electrical enclosures for indoor applications shall be NEMA Type 12, with gasketed, bolted or latching covers. Indoor enclosures shall be Hoffman Type CH, or equal.

## PART 3: EXECUTION

3.1 GENERAL

A. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

B. Coordinate electrical work with the Owner and work of other trades to avoid conflicts, errors, and delays.

C. Check the approximate locations of light fixtures, electrical outlets, equipment, and

other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer. The Engineer's decision shall govern. Make modifications and changes required.

D. Provide all conduit, wiring, and connections for Owner's existing equipment, or new equipment specified under other Sections. Obtain required information from the other trades and rough-in to meet requirements of said equipment. No allowance will be made for failure to comply with obtaining complete information from other trades.

## 3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss or damages in accordance with provisions elsewhere in these Contract Documents. Protect everything from the effects of weather.

B. Items that are subject to corrosion under damp conditions and items containing electrical insulation, such as transformers, conductors, motors, and controls, shall be stored in clean, dry, indoor, heated locations.

C. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction.

## 3.3 MATERIAL AND EQUIPMENT INSTALLATION

A. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's decision. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

## 3.4 CUTTING AND PATCHING

A. Lay out work carefully in advance. Do not cut or notch any structural member of building surface without specific approval of Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition.

3.5 MOTOR ROTATION

A. After final service connections are made, check and correct if necessary the rotation of all motors.

B. Coordinate rotation checks with the Engineer and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that rotation has been checked and corrected.

3.6 CLEANING AND TOUCH PAINTING

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

3.7 HAZARDOUS AREAS

A. Install all materials and equipment in hazardous areas in a manner acceptable to the regulatory authority having jurisdiction for the Class, Division, and Group of hazardous area indicated.

3.8 CONDUIT

A. All power and instrumentations conductors shall be installed in conduit in accordance with the following table, unless otherwise indicated in the Drawings:

| **AREA** | **CONDUIT** |
|---|---|
| Exterior | Rigid Steel or IMC |
| Interior exposed | Rigid Steel or IMC |
| Interior concealed | EMT |
| Interior lighting and receptacles exposed or concealed | EMT |
| Underground, earth burial | PVC |
| Embedded in concrete | PVC |

B. The flexible conduit shall be long enough to allow the item to which it is connected to be withdrawn or moved off its base. Use liquid-tight flexible metal conduit in outside areas, process areas exposed to moisture, and areas required to be oil tight and dust-tight. Use flexible conduit in other areas.

C. Flexible conduit used in dry areas for final connections to lighting fixtures or appliances may be non-liquid-tight, flexible steel conduit.

D. Special Locations.

1. Use rigid steel conduit or IMC:
   a. Where conduit changes from underground and/or concrete embedded to exposed.
   b. Under equipment mounting pads.
   c. In exterior light pole foundations.

E. Provide all necessary sleeves and chases required where conduits pass through floors and walls, seal all openings and finish to match adjacent surfaces. Provide escutcheon plates where exposed conduits pass through walls, floors or ceilings.

F. Conduits entering cabinets, pull boxes or outlet boxes shall be secured with double galvanized locknuts, one inside and outside of box, and bushings.

G. Conduit shall be sized in accordance with the NEC and shall be of such size and so installed that conductors may be drawn in without injury or excessive strain.

H. Make final connection to motors, wall or ceiling mounted fans, HVAC equipment, valves, local instrumentation, and other equipment where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, with 18-inch minimum, 60-inch maximum lengths of liquid-tight, PVC jacketed, flexible steel conduit where the required conduit size is 4 inches or less. For larger sizes, use nonflexible conduit as specified.

I. All roof and exterior wall penetrations shall be sealed with a waterproof, non-sag sealant. Sealant shall be applied to both the exterior and interior of conduits.

J. Direct Earth Burial Conduit Zone Backfill Installation.

1. Backfill material for the conduit zone of direct burial conduit trenches may be selected from the excavated material if it is free from roots, foreign material, and oversized particles. Use material with ¾ inch maximum particle size and suitable gradation for satisfactory compaction. Sort material if necessary to meet these requirements. Carefully tamp around and over conduits with hand

tampers.

2. Imported ¾ inch minus gravel or sand may be used in lieu of material from the excavation.
3. After conduits have been properly installed and bedded, backfill the trench above conduits with material meeting the requirements of Section 02/221, TRENCH EXCAVATION AND BACKFILL.
4. Final conduit cover shall be 12 inches minimum.

K. Prohibition Against Installing Instrumentation Cable in Conduit with Power Conductors.

1. Instrumentation cable shall be placed in separate conduit runs, and may not be installed in the same conduit as power distribution conductors.
2. Instrumentation cable conduit runs in parallel with power distribution conductors and/or conduits must be laid with a minimum of 18 inches of spatial separation.
3. Instrumentation cable shall not be routed through junction boxes shared by power distribution conductors.

## 3.9 GROUNDING

A. All services, panelboard cabinets, equipment and enclosures, and the complete conduit system shall be grounded securely in accordance with pertinent sections of Article 250 of the NEC. All electrically operated equipment shall be bonded to the grounding conduit system. Grounding shall include the grounding conductors as specified.

## 3.10 OUTLET AND JUNCTION BOXES

A. Provide a box suitable for the conditions encountered at each outlet in the wiring or raceway system and sized in accordance with the NEC.

B. Install boxes in a secure, substantial manner supported independently of conduit by attachment to the structure. Boxes embedded in concrete or masonry need not be additionally supported. Utilize galvanized mounting hardware in industrial areas.

C. Install boxes for conduits below grade flush with finished grade. Boxes in paved areas, roadways, or walkways shall be boxes and covers suitable for the weights to which they may be subjected.

D. Box mounting height: Unless otherwise noted, install lighting and receptacle boxes with centerline at following heights:

1. Install light switch boxes at 48 inches above finished floor.

2. Install receptacle boxes in office areas at 12-inches above finished floor.
3. Install receptacle boxes in process areas at 24-inches above finished floor.
4. Install counter-top receptacles 8-inches above counter top.

3.11 WIRING

A. No wire shall be drawn into conduit until conduit system is complete. Lubricant shall be approved by wire manufacturer.

3.12 COLOR MARKINGS

A. Where two or more conduits run to a single outlet box, each circuit shall be color coded as a guide in making connections. Colors shall be carried continuously throughout the system if more than one multi-wire branch circuit is carried through a single raceway. All circuit conductors of the same color shall be connected to the same underground feeder conductor throughout the installation.

3.13 CIRCUITS

A. Deviations from conduit runs will be permitted with the engineers approval. Combining circuits in single conduit is permitted with proper identification and wire derating.

3.14 LIGHTING FIXTURES

A. Furnish and install all lighting fixtures, complete with lamps and accessories, as indicated. Electrical Contractor shall verify ceiling construction, hanger length, etc., prior to ordering fixture.

B. Photocells for photocell-actuated light fixtures shall be installed to prevent nuisance turn-on’s by vehicle headlights or interior building lighting when doors are open. Position photocells on the opposite-from-opening side of (and not above) doorways, and on a building side away from normal vehicle access.

3.15 MOTOR STARTERS

A. Field adjust the trip settings of all motor starter magnetic trip only circuit breakers in accordance with manufacturer's instructions. Determine motor rated current from motor nameplate following installation.

3.16 LIGHTING AND DISTRIBUTION PANEL BOARDS

A. Mount panelboards securely where indicated, plumb, in-line, and square with walls. Unless otherwise indicated, mount panelboard with top of its cabinet approximately 6

feet above the floor. Provide a typewritten circuit directory under a metal framed transparent plastic cover inside each panelboard. Provide an engraved, laminated plastic nameplate on the outside of the panelboard showing the panelboard designation, voltage, and phases.

## 3.17 DRY TYPE TRANSFORMERS (0 TO 600 VOLTS)

A. Mount transformers approximately where indicated. Load any vibration isolators external to the unit properly and provide complete isolation with no direct transformer unit metal contact with the mounting surface. Connect electrical circuits to transformers by means of moisture proof, flexible conduit in a manner that prevents transformer vibrations from being transmitted to the building or other equipment.

B. Ground neutrals and enclosures of all transformers in accordance with applicable codes and as otherwise may be indicated. Connect voltage taps on all transformers to give as close as possible to rated output voltage under normal plant load conditions.

## 3.18 LOAD BALANCE

A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment; however, after installation, if necessary, balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, etc.

## 3.19 TESTS

A. Operations. After the electrical system installation is completed and at such time as the Engineer may indicate, conduct an operating test for approval. Demonstrate that the equipment operates in accordance with the requirements of these Specifications and Drawings. Perform the test in the presence of the Engineer. Furnish all instruments and personnel required for the tests. The Owner will furnish the necessary electric power.

B. Voltage.

1. When the installation is essentially complete and the plant is in operation, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
2. At the request of the Engineer, record the supply voltage for 24 hours during a normal working day.
3. If the unbalance (as defined by NEMA) exceeds 1 percent, or if the voltage varies throughout the day and from loaded to unloaded conditions more than

plus or minus 4 percent of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, obtain from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.

4. Equipment Line Current. Check the line current in each phase for each piece of equipment. If the power company makes adjustments to the supply voltage magnitude or balance, make the line current check after the adjustments are made. If any phase current in any piece of equipment is above the rated nameplate current, determine and submit in writing to the Engineer the cause of the problem.

## 3.20 ELECTRICAL PERMITS AND INSPECTIONS

A. The Contractor shall be responsible for obtaining all required electrical building permits and inspections required for the work, including any associated fees.

B. All materials, equipment, and workmanship shall be subject to inspection at any time by the Engineer. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer.

## 3.21 SPARE PARTS

A. Provide the following spare parts (in the quantities indicated) under this Section:

1. Panel-mounted indicator light bulbs -- (3) of each size and type used in the Work.
2. Panel-mounted indicator light colored lenses -- (1) of each size, color, and type used in the Work.

## 3.22 OPERATIONS AND MAINTENANCE MANUALS

A. Provide operations and maintenance manuals. Provide five copies including, as a minimum, all information listed below in one or more three ring binders.

1. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
2. Set of complete as-reviewed information herein required to be submitted for review following Contract award.
3. As-built electric circuit and equipment drawings.
4. Index of all equipment suppliers listing current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.
5. As-built Contract Drawings on reproducible sepia showing all departures

from original Drawings. Show all underground cable, conduit, or duct runs dimensioned from established building lines, and all electrical work revisions. Prepare by obtaining new, clean sets of Contract Drawings from Engineer and pay all costs for same.

6. All field and factory test results.
7. Information listed under individual specification items.
8. All material to be clean and filed under dividers with heading in accordance with Specification item title.
9. Submit material to Engineer for approval prior to delivery to Owner; make additions or changes as required by the Engineer.

**END OF SECTION 16005**